ELECTRICAL REVIEW

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The Steam Record of a Year.

The rapid introduction of electricity has called forth many refinements in steam engineering, the production of which have in no small degree contributed to its popularity. The reliable generation of uniform current with utmost economy has been the aim of the electrical engineer, and in the attainment of his desire he begins at the coal pile, because he must generate his steam uniformly as required, turning it into his engine for final use in operating the dynamo.

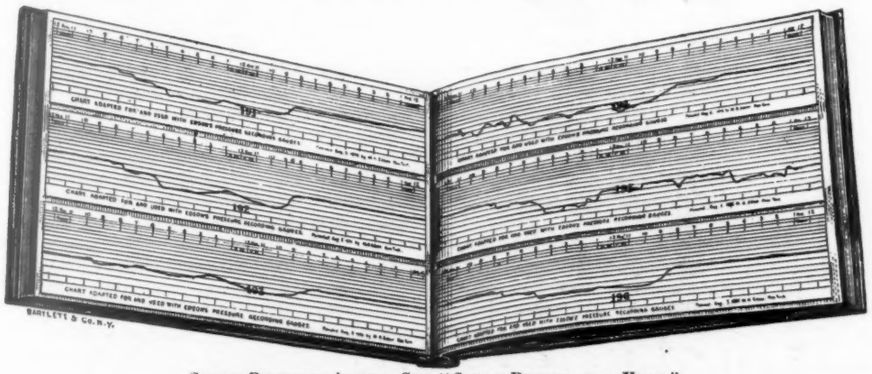
A moment's reflection must make it apparent to the most superficial mind, that for maximum economy it is important that intelligent attention be given to the manner of obtaining the utmost heat units from the coal provided, and that in order to obtain proper combustion in the furnace it is necessary to preserve a high temperature, for otherwise the coal will be consumed and pass off with the products of combustion, but without having yielded what it is capable of, the result being quite difficult, whether it goes off carbonic oxide or carbonic acid gas.

Most every one familiar with the increased heating capacity of illuminating gas when employed in the Bunsen burner, in which case this increased efficiency is not due to any additional consumption of the gas, but simply owing to the manner of its employment and the thoroughness of its combustion. Now, the steam boiler furnace is virtually intended to be operated as a gas producer, and for which purpose it is at best but poorly designed, so that in many large plants the coal is first distilled into gas in a separate chamber, and then conveyed around the boiler and burned with very great economy.

It is chiefly in connection with this subject of furnace economy that has led us to present our readers with an illustration of a portion of a year's steam record, shown in the chart album on this page, because a "straight line" record of pressure means the closest attention of the fireman and the employment of his best knowledge of the laws of combustion, while a crooked one generally indicates gross lack of attention or total ignorance of these laws, or both.

It requires no argument to prove the value of such an ocular demonstration. When the result of a man's fidelity and labor are to pass unknown and unrecorded, indifference will prevail, while the reverse is equally true.

If the result of this indifference means waste of coal, varying and injurious strains upon the boiler, irregular steam pressure to the engine, retarded cut-off and reduced expansion economy in the cylinder, coupled with inefficient regulation of revolution of the engine and varying current from the dynamo, it would seem of the utmost importance to secure a remedy, particularly where steam power is employed for electrical purposes, and we consider that the benefits of thus graphically setting before the eye of the master the automatically written facts, come but little short of supreme importance in any well conducted steam plant. At any rate, we voice the opinion of many of the leading engineering authorities on the subject of steam engineering, when we say that the importance of the steam pressure recorder has been too long overlooked, because without it the fuel is most ruthlessly used, and the science of combustion regarded with the utmost indifference. Nor does the loss terminate at this point, for an engine designed to cut-off at a given point with 80 pounds of steam, cannot do so if the boiler pressure is maintained with indifference as to what it may be. This loss in the cylinder occurs twice in each revolution. Again, in electric lighting, uniformity of revolution is sought, but rendered more difficult when the initial steam pressure varies, so that from many standpoints it seems of paramount importance for efficiency and economy, to say nothing of safety, that a pressure record should be under the eye of the superintendent.



STEAM PRESSURE ALBUM—SEE "STEAM RECORD OF A YEAR."

New York Electric Club.

Captain E. L. Zalinski, one of the Club's well-liked members, is spoken of as follows in the *World* of this city:

"The recent prominence given to Captain Zalinski, of the United States Army, reminds me of an incident when he was a new second lieutenant at Fortress Monroe. Some assignments to duty had been made which would send three or four officers, Zalinski among them, to Key West and Dry Tortugas in the height of the yellow fever season. There was much adverse criticism among the officers, and one, adverting to Zalinski, intimated that the stripling lieutenant's personal courage was unequal to the assignment. The next evening, after dress parade, when all the officers in the garrison were assembled about the commanding officer, Zalinski deliberately slapped his detractor's face, and spent the intervening time before his departure for Florida in close arrest. He was not challenged."

President Madden, of the Club, is enjoying the privilege of explaining to his friends the following account of his visit to Carlsbad, which appeared in the New York *Press:*

General O. E. Madden, president of the Electric Club, was in ill-health last Spring, and decided to go abroad to recuperate. He drifted around Europe awhile, and finally, at Rome, was attacked with cramps, and concluded to go to Carlsbad. He had been at the famous springs for about two months under the regimen of a local physician, during which time he had gained two pounds in weight and had the feeling of a fighting cock, when one morning his physician said to him:

"Sheneral, my tarling, you vas gain two pounds, I am told. I do not understand it.
You vas take der spring vater as I directed?"

"Yes, doctor; every morning," replied the General, not knowing what was coming.

"Und you vas take a long valk?"

"Yes, doctor; just as you told me."

"Vell, dat vas queer. I must reflect."

Laying his forefinger alongside of his nose, the old German physician assumed a thoughtful air for a moment, and then continued his questioning:

"You vas not dissipating, Sheneral? You have not drank anyting vile you vas here?"

"Not a drop of anything but water. I couldn't stomach that wine you said I might drink, so I didn't drink anything."

"Und you has kept good habits and good hours?"

"Certainly, doctor."

"Well, say, Sheneral, vat did the doctor vat sent you here say vas the matter mit you?"

"No doctor sent me here. I was not examined by any doctor. No doctor said anything was the matter with me."

"Vell," said the old German, with a huge sigh of relief, "dat vas vhat I dink, too, dat dere vasn't anyting de matter mit you."

General Madden concluded to start for New York the same day.

Mr. J. C. Chamberlain, chairman of the House Committee, is convalescing from a severe illness. Matters looked serious for a time, but we are glad to state Mr. Chamberlain has sufficiently recovered to go out-doors for a short time every day.

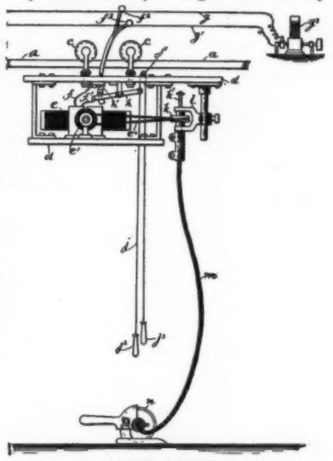
Among recent out-of-town names on the register are W. B. Pearson, Chicago; Prof. James F. Colby, Hanover, N. H.; Charles E. Chapin, Hartford; Emil Huber, Zürich, Switzerland; A. H. Chadbourne, Philadelphia.

About Time to Investigate.

The officials of the Edison General Electric company will request the State board of health to make an examination of the sanitary condition of Schenectady, says the Troy, N. Y., *Press.* There has never been so much sickness in Schenectady before. It is stated by officers of the Edison Company that from 150 to 200 of their 3,000 employés are absent every day on account of sickness. The sickness, which is mainly typhoid fever, is due to defective sewerage and impure drinking water.

Electric Cloth-Cutting Machine.

In cloak and other factories for the manufacture of garments it is customary to have a number of tables upon which the cloth is arranged and marked in patterns, after which it is transferred to and secured upon the cutting table, where the usual cutting machine is located. An instrument has been recently patented by Mr. Elbert D. Weyburn, of Chicago, by which a cloth-cutting device, operated by an electro-motor, may be moved upon a guide-rail to any



CLOTH-CUTTER

part of the cloth-cutting room at the will of the operator. The advantage of portability secured by such an instrument is very great in this particular application. The invention is illustrated in the accompanying diagram, wherein is shown an electro-motor *e* mounted upon a frame supported by rollers *c, c,* upon a guide-rail *a* extending along the cutting room. The terminals of the motor are connected by means of a switch *h,* with two contact rollers f^2, f^3 moving in operative relation to a circuit supplied by a dynamo or other source of electrical energy. The switch is controlled by means of a pulley and handles, as shown, so that the operator can readily start or stop the machine by pulling one handle or the other. The motor drives a spindle attached to a flexible shaft *m,* which drives the cutting wheel of the cloth-cutting device. The operator in using the instrument lifts the cutter and moves the apparatus along its guide-rail to the desired table and the cutter is placed upon the cloth, current switched on, and the work rapidly and efficiently performed. The transfer is then made to another table and the operation similarly conducted at that point.

Certainly Low Enough Now.

At a meeting of the gas commission, December 22, another batch of bids from the New York electric lighting companies was opened. These latest bids averaged 40 cents per lamp, per night, which will bring the cost of city electric lighting within the appropriation for 1891. There are 1,386 arc lamps in the city proper and 266 in the annexed district. The commission will have to hustle now for an excuse for not awarding the contracts, as they seem to have got things pretty much as they want them.

LATER.—The Gas Commission met Dec. 26th, and accepted the bids as above. The Board of Estimate and Apportionment has inserted an item of $60,000 in the appropriation of the Public Works Department to meet this expense.

Detroit Motor Company.

Among the prominent changes made by electrical manufacturers is the removal of the Detroit Motor Company from their old quarters on Griswold street to the new factory on Cass avenue, Detroit. The ground on which the new buildings are located was purchased in June last. On July 4 the ground was first broken, and on October 4, just three months afterwards, fires were built in the large boilers and the new shops were in full blast.

A good idea can be had of the size of the factory by referring to our illustration, presented herewith. The main building is three stories in height, with a frontage on Cass avenue of 150 feet and a depth of 75 feet; the machine shop, directly in the rear, is 300 feet in length by 75 in width, giving altogether a total of 56,250 square feet of floor space. Every foot of space is utilized throughout the entire building, which will give the reader an idea of the growth of this company, when it is understood that the old quarters gave them only about 16,000 square feet of floor space. The factory being located, as it is, on the line of three railroads, has the best of shipping facilities. Electric power is used throughout the entire plant, which is also lighted by incandescent lights, run during the day from a dynamo, and during the night from a storage battery plant.

The company have, until recently, confined themselves to the manufacture of stationary motors, but have now a new type of dynamo which they are building in 18 sizes, ranging from 1,100 watts to 160,000 watts. Patterns are finished for these sizes. The accompanying illustration, Fig. 2, shows the new machine, which has a capacity of 325 lights.

The 80,000 watt machine weighs 13,000 pounds, and has an output of 145 amperes, at 550 volts, running at a speed of 480 revolutions per minute. The armature of this machine, which is 107 horse-power capacity, is 12 inches in diameter and 26 inches long. This is made of 850 charcoal iron disks, separated by rice paper, the oxide having first been removed from the iron. The magnet cores are of the softest forged iron. Through each of these clearance holes are bored, and the bolts passing through, screw into the bottom of the pole pieces, the other end being fastened under the yoke bed. Each part of the machine is held in place by dowel pins, and in this way is made easily interchangeable.

The success of this company has been the best from the start, and they now report having all the orders they can fill for some time to come.

The Torpedo Station at Newport.

The following notes from the records of the Naval Torpedo Station and War College, Newport, contain much interesting matter. All the electrical work at this establishment is under the charge of Lieut. T. C. McLean, who is one of the pioneer electricians of the Navy:

The work in the electrical laboratory has included the regular duties connected with the maintenance and use of the electric light plant for lighting the buildings, grounds, wharves, etc., and the inspection of wires, cables and other electrical apparatus.

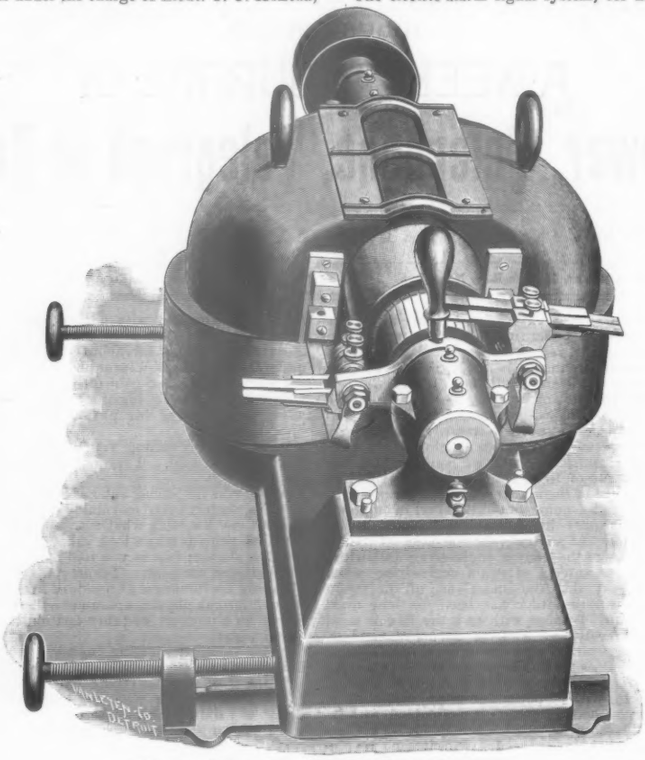


FIG. 2.—DYNAMO OF DETROIT MOTOR COMPANY.

The construction of the search-light apparatus for the "Charleston," the "Baltimore" and the "Philadelphia" was done by the Thomson-Houston Electric Company, under the supervision and inspection of this station. The earnest efforts of the contractors to bestow upon this apparatus all the good qualities that their own experience and that of the inspecting officer suggested, was very noticeable. The result was efficient apparatus of American construction quite equal to, and in some respects superior to, any produced elsewhere.

The electric alarm signal system, for fire signals and other purposes, embracing all the shops, offices, quarters, etc., of the station, has been reorganized and changed so that its efficiency and reliability have been greatly improved. In this system, 16 vibrating alarm bells are included in one series circuit extending around the station. Each bell had individual adjustments and action, similar to that of the ordinary vibrating bells. The continuity of the circuit can be tested without ringing the alarm, and bells of different sizes and rates of vibration can be operated in the same circuit. This system seems well adapted for use in the general alarm circuits of ships.

A compact form of firing battery has been constructed for special use with naval mines and torpedoes.

An experimental apparatus for signaling ranges, etc., from the conning tower or other central station, to the gun positions, has been developed and seems capable of satisfactory service. The apparatus is in process of construction. A combination of apparatus has been made by which the indications of a voltmeter are automatically repeated and recorded at a distant point.

Preparations have been made for the installation of a storage battery for experimental and testing purposes.

A single cylinder vertical engine has been combined with a dynamo, on the same bed plate, the driving connection being made by the Evans friction belts and pulleys, the speed of the dynamo pulley being about twice that of the engine. This makes a compact arrangement of dynamo and engine, allows the use of a moderate speed engine with a dynamo of high speed, and obviates the necessity of a flexible coupling. It also affords fairly good insulation for engine and dynamo connection.

With a view to developing a dynamo for launches and torpedo boats, a new pattern Dow turbo-motor has been combined with a Parsons dynamo. The substitution of this motor for the Parsons motor makes a large reduction in the weight and in the space occupied, but at present it has rather a low steam efficiency and it makes a loud humming noise like its predecessor. Experiments are continuing for the reduction of the noise. Both motor and dynamo are run at a speed of about 10,000 revolutions per minute. The action of the Parsons governor for controlling the voltage at the terminals of the dynamo is found to be very satisfactory.

A good feature of this motor is its almost absolute immunity from damage by water coming over with the steam. It can, therefore, be quickly started, with no delay for draining, warming up, etc. After some improvement this apparatus might prove useful for certain purposes where compactness, simplicity, close governing and freedom from injury by water in the steam supply would be valuable features.

Lieut. McLean is the inventor of a very ingenious apparatus designed for the continuous registration of the revolutions of the screws of the torpedo boat "Cushing," together with the seconds' intervals of time as shown by a break circuit chronometer, and the times at which the boat crossed the range line at the ends of the measured mile course, as marked by three independent circuit closing keys (for three independent observers). The design included the feature of accurate determination of rates of revolutions of the screws at the times of taking indicator cards of the engines. The design and arrangement of the parts was simple. The revolution registering circuits were completed at the shafts by pieces of sheet brass attached to circular wooden sectors secured on the shafts. These devices were very simple and efficient. They could be securely lashed or clamped to the shafts in a few minutes. The arrangement of circuits, etc., for registering the seconds' beats of the chronometer and the time marks of the observations, in lines parallel to and contiguous to the lines of the marks registering the revolutions of the screws, were similar to the arrangements used for transmission of naval observatory time signals and registrations of time comparisons with them.

The apparatus was used with satisfactory results in March last by the board appointed by the Secretary of the Navy to conduct and report upon the tests of the "Cushing" before her acceptance from the contractors. The installation of such apparatus on any steamer is very easily made, and it comprises very simple circuit closers on the screw shafts, a box for the battery, and a small table for the registering apparatus (chronometer and chronograph), which can be placed in a chart house or any other convenient positions in the ship easily accessible to the members of the trial board and the contractors' representative; several circuit closer keys, or push buttons, in the hands of observers at any convenient positions, and such lengths of ordinary insulated wires as would be required to complete the circuits. The wires would not require battens or any other features of permanent leads.

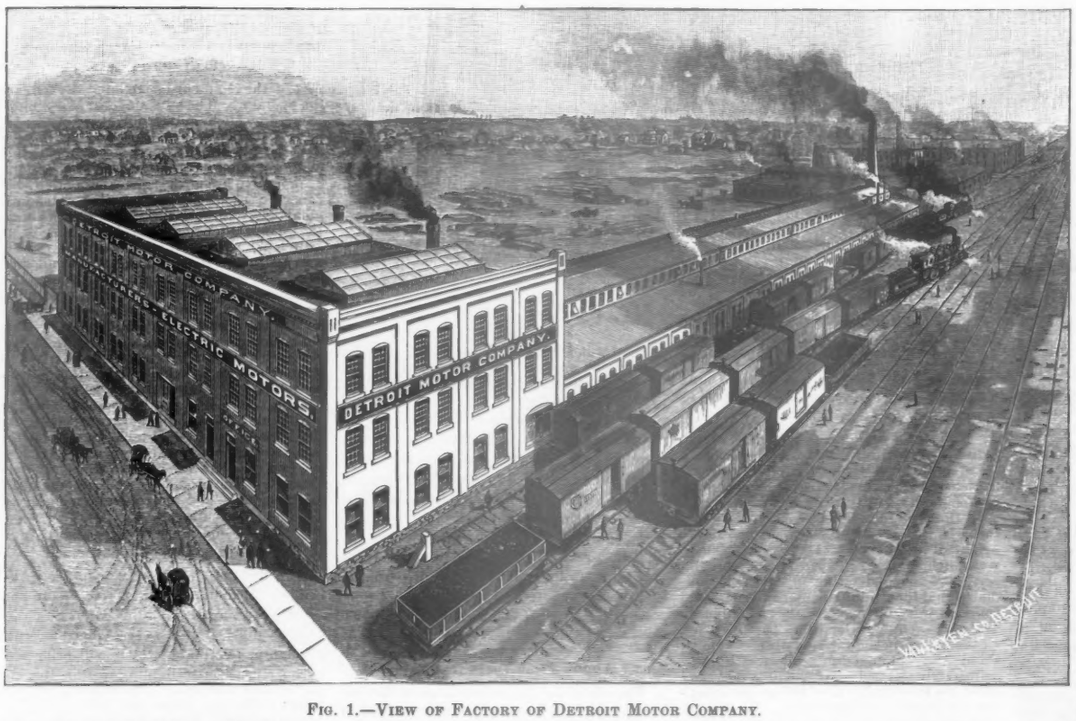


FIG. 1.—VIEW OF FACTORY OF DETROIT MOTOR COMPANY.

VIEWS, NEWS AND INTERVIEWS.

Mr. A. O. Tate, Thomas A. Edison's private secretary, has been confined to his home for the past two weeks with an acute attack of inflammatory rheumatism.

Boston had the first electric fire alarm telegraph system and New Orleans the second. New York was not equipped with this now universal apparatus until about 1864.

Edison's private laboratory, at Llewellyn, N. J., is completely hedged about by a high white picket fence. The various buildings make an agglomeration of factories as large as those of many manufacturing establishments. And yet this is but an experimental laboratory where multitudinous schemes are evolved, tried and condemned or perfected, as the case may be.

It is doubtful if there is a harder working or more enthusiastic body of men than Edison and his assistants. When a line of experiment or research is started nothing must or does interfere with the worker until a result, negative or positive, is reached. This one desideratum is alone sufficient excuse for the picket fence. As an additional safeguard, a little lodge has been recently built near the main gate in the picket fence. Through it is the only path of ingress or egress to the scientific wonderland within. Posted conspicuously in the lodge are two signs, printed in unmistakably large type, which read this way:

EDISON LABORATORY.

NOTICE.

All business matters are conducted by Mr. Tate. Mr. Edison is, in justice to his work, compelled to deny absolutely all personal interviews except when appointment has been previously arranged by letter.

No permits can be issued to visitors to enter these premises.

The picket fence, the lodge, the signs, and a faithful corps of attachés make Edison's private laboratory as impregnable as an ancient fortress with moat and drawbridge.

Charles Losee, a convict recently released from Sing Sing, told a New York *Sun* reporter that E. F. Davis, Harold P. Brown's man, turned the switch which caused Kemmler's death. Losee assisted Davis in preparing the execution apparatus and says that Davis himself acknowledged that he was the man who killed Kemmler.

"If people who use the telephone," said an exchange manager, "would only remember that one strong turn of the crank does just as much as 20 turns to call the attention of the operator, they would earn the thanks of that much abused and long suffering class. A light motion of the bell handle causes a little shutter with the subscriber's number painted on it to drop into view before the operator. Any additional ringing only causes annoyance to the girl, who has a receiver fastened to her ear by a spring passing over her head. The constant sound of the bell in the operator's ear has been known to break the drum of the ear."

The London Telephone Service.

It is stated that London telephone subscribers are soon to have metal return wires. This will eliminate the "cross-talk" which is so annoying at present. Instead of a subscriber calling out "Are you there" several times, and being told to speak nearer or farther away from the transmitter, and then failing entirely to make his correspondent understand who he is or what he wants, we may hope that he will soon be able to carry on a conversation with fair success and without loss of temper.—*Industries.*

An Old Chestnut With New Prickles.

One of the Hotel Duquesne guests, evidently a railroad man, noticed that the telegraph operator was at leisure about 8:30 o'clock last evening, and soon began a telegraph correspondence with him. As a sender he used a lead pencil and the show case. The operator had no difficulty in catching everything. The gentleman declared that he could do much better on a piano, as it was upon that he learned.

"I have taught my daughter telegraphy on the piano," said he, "and we have great times holding our conversations from either end of the instrument. We both use the same instrument, though, which does not often occur with *bona fide* telegraphy."—*Pittsburgh Dispatch.*

Must Pay Taxes.

At Harrisburg, Pa., December 18th, in an elaborate opinion, Judge Simonton decided the case of the Commonwealth against the Brush Electric Light Company, of Philadelphia, in favor of the State, except as to one point, that stock invested in patent rights granted by the United States is not taxable, which is decided in favor of the defendant.

The company claimed to be engaged in manufacturing, and, therefore, to be exempt from taxation on its capital stock. It also contended the tax imposed on capital stock by the revenue act of 1889 was wholly unconstitutional because of its lack of equity and uniformity. Judge Simonton, as in a former opinion, holds that producing electric light is not manufacturing. The case will probably be carried to the Supreme Court.

What She Had Heard Before.

A little tot, whose papa has a telephone in the house, has been an interested listener to his conversation through the 'phone, and, the other day when the bell rang, she stepped up to the instrument and said: "Hello! hello! Well, damn it, what do you want?"

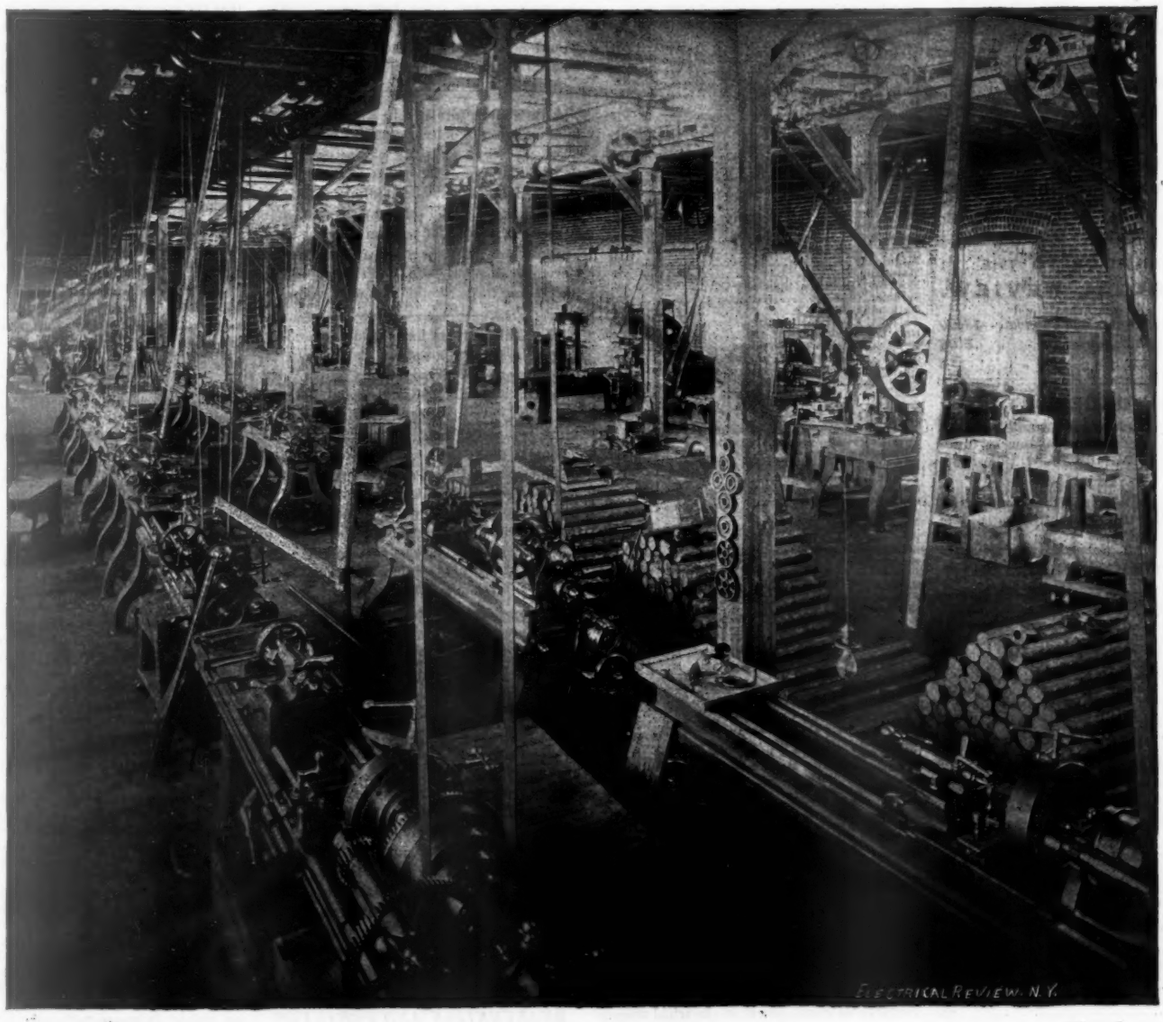


FIG. 8.—MACHINE SHOP OF DETROIT MOTOR COMPANY.

New Haven, Conn.—Tramway Construction Company; capital, $20,000.

Sharpsville, Pa.—The Sharpsville Electric Light Company; capital, $15,000.

Detroit, Mich.—The capital stock of the Detroit Electrical Works has been increased to $500,000.

Pueblo, Col.—American District Telegraph and Messenger Service Company; capital, $20,000.

Bement, Ill.—The Bement Electric Light and Power Company; capital, $10,000; to furnish electric light and power.

Montclair, Col.—The Montclair Electric Light Company; capital, $20,000. Incorporators, H. W. Lawrence, W. F. Reed and W. C. Howe.

Chicago, Ill.—The Prouty Street Car Motor Company; capital, $300,000. Incorporators, Enoch Prouty, J. L. Francis and W. S. Gooding.

Riverside, Ill.—The Riverside (Cook County) Edison Company, to furnish electric light and power; capital, $40,000. Incorporators, W. H. Hutchinson, Lewis Lusk and M. C. Meyers.

Buffalo, N. Y.—The Bell Telephone Company, of Buffalo, has filed with the Secretary of State of New York, a certificate showing an increase of its capital stock from $800,000 to $1,000,000.

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EDITORS:

GEO. WORTHINGTON. CHAS. W. PRICE.

ASSOCIATE EDITORS:

ROBT. H. READ. STEPHEN L. COLES.

BUSINESS STAFF:

GEO. WORTHINGTON, President. CHAS. W. PRICE, Secretary.

ROBT. H. READ, Manager Patent Bureau.

H. T. RICHARDS, Mgr. Advertising Department.

BOSTON OFFICE:

W. I. BARKER, Room 29, 620 Atlantic Ave.

WASHINGTON OFFICE:

GEO. C. MAYNARD, 1409 New York Ave.

CHICAGO OFFICE:

D. B. DEAN, 163 Randolph Street.

EUROPEAN OFFICE:

CHARLES FFRENCH, Bridge House, 181 Queen Victoria St., London, E. C.

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No attention will be paid to communications for the REVIEW without the *name and address of the writer.*

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"A PROGRESSIVE NEW YEAR!" to the electrical fraternity, is a sentiment in keeping with our art and the times.

A subscription to the ELECTRICAL REVIEW makes a splendid New Year's present. T. and S.—which is to say, try and see.

Business never was better among the electrical supply companies. Orders are booked for months ahead, and nearly every factory is running over-time. Yet it is with the greatest difficulty that sufficient collections are made to meet pay rolls. Every one is cheerful, nevertheless, and all predict better times soon. This is the sort of feeling sure to bring better times.

The Brooklyn bridge cable has a bad habit of breaking at the splice. Besides, the splice is of greater diameter than the cable itself; this makes trouble with the grip on the car. Maybe the grip has something to do with making these bad breaks. Why not electrically weld the cable? The joint would be as strong as the cable itself and would be approximately the same size.

A Pittsburgh minister in a recent sermon took occasion to deliver diatribes against the overhead wires and lack of fire escapes in that city. We believe this is the first instance of ecclesiastical meddling with electrical matters. The daily newspaper man is a scientific wonder compared to the average minister, when it comes to questions of electricity. What both don't know about the coming force would fill many volumes.

The daily papers have lately contained numerous paragraphs about the Mount Carmel Aeronautic Navigation Company, of Chicago, with $20,000,000 capital, all paid up. We have kept pretty quiet about airships, because so many fakirs have used that scheme to make their pocket books apoplectic and rotund. Nevertheless, we put ourselves on record as believing, when air travel becomes a practical reality, if it ever does, that electricity will have more or less to do with it—probably a great deal more. The idea that aerial navigation would make every village and town on the globe a port of entry is one to be considered—when aerial navigation comes.

A panic occurred during a matinee performance at the Fifth Avenue theatre on Christmas Day. The cause was the ignition of some wax and paper flower decorations on an electrolier in the lobby of the theatre. It appears that the electrolier was partly wired with cotton and paraffine covered wire. Fortunately, the fire did no damage, and the panic—chiefly due to an excitable idiot who shouted "fire"—was quickly quelled. If the report of the paraffine wiring be true we are of opinion that the parties responsible for its use are deserving of severe treatment, quite as much as the aforementioned excitable idiot who alarmed the entire audience by his officiousness.

RE-INVENTION AND PRE-INVENTION.

It is amusing to note the airy grandeur with which some people assert proprietorship of original ideas. In the *English Mechanic and World of Science*, for December 5, Mr. Henry Sutton makes the following statement:

"In the paper to the Royal Society on the copper-lead storage cell I described means of producing high voltage by arranging plates in grooves in series which on charging, one side of each plate becomes positive and the other side negative. This idea published in 1881, has since then been three times re-invented, and, I believe, is in the market."

Mr. Sutton is evidently not aware that Camille A. Faure described such a series arrangement in his original United States patent, filed in April, 1881, and in his French patent of 1880, and that Charles F. Brush described exactly the same arrangement in his United States patent, filed June, '81. This is *re-invention* with a pre-antepenultimate *P.*

HAPPY NEW YEAR!

The Brooklyn bridge management deserves a leather medal. Its inefficiency is almost sublime.

It is safe to predict that there will be some remarkable development in electrical science before '91 departs.

Keep your eyes on the storage battery. There are too many able men at work on this problem not to produce new and good results.

Chicago inventors claim to have worked out an automatic telephone exchange, and announce that the central office girl will have to go. She will be missed.

Another severe storm has knocked down wires all along the Atlantic coast and for some distance inland. Repair gangs have been sent to all points of the compass from the Western Union office in this city.

Austrian capitalists propose to build an electric railway between Vienna and Buda-Peath which shall reduce the running time between those two places nearly 50 per cent. This is another move toward the province of the steam locomotive.

THE PULL OF SOLENOIDS.

ABSTRACT OF A CANTOR LECTURE BY SYLVANUS P. THOMPSON.

From quite early times it was known that a coil would attract a piece of iron into it and that this action resembled somewhat the action of a piston going into a cylinder in the sense of having an extended range of action. Electro-magnetic engines were made on this plan by Page and afterwards by others, but if you inquire into the literature of the text books you will find that next to no information is given on the peculiar properties of the coil and plunger arrangement. They are content to deal with the subject in very general terms by saying: "Here is a sort of sucking magnet, the core is attracted in." Some will go so far as to tell you that the pull is greatest when the core is about half way in, a statement which is true in one particular case but false in a great many others; another false statement sometimes made is that the pull is greatest at a point one centimeter below the center of the coil for plungers of different lengths; another book will tell you that a wide coil pulls less powerfully than a narrow one, a statement true for some cases and not for others; the books also give you some approximate rules which are very little to the point. This is a subject of great importance, because the coil and plunger mechanism vastly extends the range of pull of the electro-magnet. Some experiments made by Mr. Hunt in 1856 illustrate this difference in range. A horse-shoe magnet with its armature in contact exerted a pull of 220 pounds; at a distance of $\frac{1}{250}$ of an inch the pull fell to 90 pounds; at a distance of $\frac{1}{50}$ of an inch the pull fell to 36 pounds. A Hjörth magnet, which consists of a coil provided with a hollow conical core of iron closed at one end, exerted a pull upon another electro-magnet at a distance of one inch, with a very much larger apparatus than Hunt's, of 160 pounds; at 3 inches, 88 pounds; at 5 inches, 72 pounds. Here is a range of action extending over not $\frac{1}{50}$ of an inch, but over five inches, and falling not from 230 to 226, but from 160 to 72, obviously a much more equable kind of range. The most eminent electricians of the day, Joule, Cowper, Sir William Thompson, Grove and Tyndall, discussed these matters and all came to the conclusion that electro-motors would never pay. Of course, they were reasoning from the point of view that a primary battery was the source of energy. Robert Stephenson said: "There could be no doubt from what had been said that the application of voltaic electricity, in whatever shape it may be useful, was entirely out of the question, commercially speaking. Mechanical applications seem to involve almost insuperable difficulties. The power exhibited by electro-magnetism, though very great, extended through so small a space as to be practically useless." From that time to the present efforts have been made to ascertain exactly how to design a long range electro-magnet, and those who have succeeded under the stress of circumstances have done so by a sort of intuitive perception. The old law of inverse squares, which is true only when one deals with electro-magnets having ends of a visible size acting on armatures themselves of visible sizes and quite close to them, constantly harassed experimenters. If you take a case which never occurs in practice—an armature of hard steel, permanently magnetized, so far away from an electro-magnet, or, rather, from one pole only, that the distance from the armature and the pole on which you are acting is so very great compared with each of them, that each of them may be regarded by comparison as a point—then the law of inverse squares may be readily applied, but not unless. Now, we want to arrive at a true law and what the law of action of the coil and plunger is. Take a long tube or coil, turn on the current so that it circulates around the coil, and a rod of soft iron held in front of the aperture will be sucked into the coil. The pull will be very small when the rod is outside, but as soon as it gets in it is applied actively, and settles down with the ends equally protruding. Take a coil provided with a single turn of wire, with a very long, permanently magnetized steel magnet, so long, indeed, that any action on the more distant pole is so feeble that it may be disregarded altogether, and only one pole, say the north pole, is near the coil, in what way will the single turn of coil act on that single pole? This is the rule: That the pole does not vary inversely as the square of the distance, nor as any power at all of the distance measured straight along the axis, but inversely as the cube of the slant distance, that is, the distance from the pole to the circumference of the coil.

CORRESPONDENCE.

DETROIT NOTES.

The Lockwood Instrument Company report business steadily on the increase. They have recently secured an order for 30 ammeters of special design for use in the new station of the Northern Electric Light Company, of Providence, R. I. They are also fitting up the Municipal Electric Light Station, St. Louis, Mo., with a new and novel device for cutting standard ammeters in circuit to take reading.

Personal.—Wm. H. Sinclair, president of the Galveston City Railway, Galveston, Texas, was a recent visitor to the factory of the Detroit Electrical Company, where he placed an order for an increase of ten motor cars of the Rae System.

Among the Recent Visitors in the city were Alex. Lewis, of the Edison General Electric Company, Chicago office, and A. H. England, secretary and treasurer of the Electric Merchandise Company, Chicago.

Detroit, December 27. D. B. D.

OUR BOSTON LETTER.

A Monster Chimney.—The cloud-scraping chimney of the "West End" power station on Albany street, this city, is about finished. The lightning rods, two in number, were successfully placed in position last week. A few finishing touches to the interior and at the top of the chimney will complete this remarkable piece of work. The chimney is 13 feet 8 inches in diameter, and in this respect is said to be the largest in the world. It is 252 feet in height, and at the base it is 26 feet 8 inches in diameter. It is made of two walls, an outer and inner, with a space of 25 inches between them at the base. The outer wall is 32 inches thick at the base and 16 inches at the top. The inner wall is 21 inches thick at the base and 8 inches at the top. It is estimated that 1,100,000 bricks have been used in this immense structure. Above the foundation there is a weight of 2,800 tons of brick and mortar. The foundation is a mass whose weight is about the same number of tons.

An Accident which caused no little excitement at the time happened recently on the Union Depot line. This line crosses the Lindell Railway at Sixth and Washington avenue. Both lines are operated by electricity. In some way the guard wires of the Union Depot line sagged so low as to touch the overhead wire on the Lindell line. With their contact an electrical display set in which attracted crowds and kept both lines at a standstill for half of an hour besides.

The Ayer Electric Light Company, of Ayer, Mass., has secured franchises from the authorities of the neighboring towns of Shirley and Groton to light the streets of those places with electrics.

Franklin, Mass.—The Union Electric Lighting Company, of the above-named town, is reported to have disposed of its property, and it is now understood to be under the control of the Thomson-Houston Electric Company.

Mr. Frank Harrington, manager of the Tropical American Telephone Company's New York department, was in this city for a few days during the week.

Mr. George T. Manson, of the Okonite Company, passed through the city yesterday *en route* for New York. Mr. Manson enjoyed his Christmas dinner with relatives in Eastern Massachusetts.

Mr. Fred. J. Boynton, the traveling auditor of the New England Telephone and Telegraph Company and treasurer of the Boston Electric Club, has returned to the city after an absence of several weeks. Mr. Boynton is now enjoying excellent health.

Mr. Geo. P. Nichols, the Chicago agent of the Thomson-Houston Motor Company, was East on a business trip during the week and spent a few days in this city.

Mr. Frank E. Knight, general manager of *Power*, one of most successful and ably edited trade journals of the metropolis—was in the city for a few days this week and a welcome guest at the rooms of the Boston Electric Club.

A New Corporation.—The Stanley Electric Manufacturing Company, Pittsfield, Mass., has received its charter and will commence business at once. The capital is $25,000. Mr. Charles Atwater is president and treasurer. This company will manufacture a general line of electrical specialties and novelties.

The Eastern Electric Cable Company, of this city, has declared its customary semi-annual dividend of three per cent. This company has been so pushed with orders that a large force has been kept busy every night for several months past.

Messrs. E. M. Carhart & Company is the name of a new electrical firm recently established at Providence, R. I. Mr. Carhart is one of the most popular and highly respected workers in the electrical field, having been identified with various enterprises, in which electricity played an important part, for about 15 years. The new firm will do a general electrical business, including a new and most improved line of electric light supplies. These will embrace the Thomas' new mast arm and Thomas' tree iron.

Telephone Bonds.—The next city government will inherit the report of the committee on bonds, on petition of the New England Telephone and Telegraph Company, of Massachusetts, recommending, in consideration of an indemnity bond given by the company for $20,000, dated September 6, 1890, that the obligation of the surety on previous bonds, dated May 9, 1889, and November 26, 1899, be released—not, however, releasing, but reserving all obligations of the principal obligors in each of the latter bonds.

An Enormous Isolated Plant.—The syndicate building or new stock exchange building on State street, though having an isolated plant of its own, with about 5,000 lights capacity, will have connections with the mains of the Edison Illuminating Company, in the street, to guard against any probability of a breakdown. From the central station current will be taken for lighting the offices, and from the dynamos all lights in the halls and water-closets will be operated. For all these lights a large switchboard is being designed, which, when finished, will probably be unequaled in New England. This plant will be the largest of the kind east of New York city.

Novel Use of Electric Motors.—At the stables of the Adams Express Company, on Congress street, this city, there is an electric motor operating two hand devices for grooming horses. It is a five horse-power machine from the works of the Eddy Electrical Manufacturing Company, Windsor, Conn. The motor is belted to a long shaft, which, by the aid of other belts, operates two pendant bars. A box containing gears, at the terminals of each of these bars, respectively, operate a flexible shaft, attached to which are spherical shaped brushes for grooming purposes. It is claimed that by this method two men can groom a horse in five minutes.

The Plume & Atwood Mfg. Co., Waterbury, Conn., keep fully abreast of the demands of the times. The company has made several additions to its factory at Waterbury, and is enlarging its rolling mill at Thomaston, and when all the changes are complete the output will be increased about 25 per cent. The most improved machinery has been put in, and the plant is in the most excellent condition for the business of the coming year. The company manufactures a varied line of brass and copper goods, and stand in the front rank in its different lines.

Armington & Sims Engine Company.—For some weeks a rumor has been current to the effect that the company above-named contemplated the building of a branch factory in St. Louis to facilitate the filling of its Western and Southern orders, which, during the past year, have steadily increased in number and magnitude. This rumor has created an erroneous impression with some that the Armington & Sims Engine Company intend to remove its entire plant from Providence to St. Louis; but those familiar with the extensive and magnificent factory and large invested interests of the company in Providence, will not be misled into believing such an absurd story. W. I. B.

Boston, Dec. 27, 1890.

PERSONAL.

Mr. H. P. Lucas, of the Great Western Electric Supply Company, Chicago, is in the city.

Mr. Frank E. Clarkson, of Atlanta, Ga., a former telephone worker of Boston, was a visitor at the ELECTRICAL REVIEW office last week.

Mr. J. A. Wetmore, formerly with the Norwich Insulated Wire Company, has tendered his resignation, to take effect the first of this year.

Mr. W. B. Pearson, of Pearson & Phelps, designers and builders of automatic machinery, Chicago, is in New York on a business trip. Mr. Pearson also represents the Ball Engine Company, of Erie, Penn.

William M. Beeson, superintendent of Bell telephone exchanges at Cincinnati, died December 21st. He was 27 years old, a native of Pittsburgh, and had been connected with telephone work for the past ten years.

George Winn, superintendent of the fire alarm system at Alleghany, Pa., while engaged in repairing a wire on a pole, December 19, fell to the ground and received injuries which caused his death. He was 50 years old and had been a city official for a long time.

Mr. H. M. Byllesby, for several years vice-president and general manager of the Westinghouse Electric Company, has tendered his resignation. Mr. Byllesby has been an active and progressive worker in electrical circles in Europe as well as in this country, and after a rest of a few months with his family in Florida, will, no doubt, again take up electrical work.

Mechanics' Fair Prizes.

The following prizes were awarded to exhibitors of electrical and kindred products, at the recent fair, at the Mechanics' Institute, Boston, Mass., October 1st to December 1st, 1890.

FIRST AWARD—GOLD MEDAL.

Thomson-Houston Motor Company.
New England Printing Telegraph Company.
Claflin & Kimball.—Mather Dynamos and Perkins Lamps.
Interior Conduit and Insulation Company.
American Magnetic Electric Company.
Westinghouse, Church, Kerr & Company.
Evans Friction Cone Company.
Woodbury Air Engine Company.
Boston Belting Company.
Faneuil Watch Tool Company.
Brown & Sharp Manufacturing Company.
C. H. McKenney & Company.
P. C. Holmes & Company.

SECOND AWARD—SILVER MEDAL.

The Holtzer-Cabot Electric Company.
Electric Safety Engine Stop Company.
Eddy Electric Motors.
A. L. Russell.
Wainwright Manufacturing Company.
Plume & Atwood Manufacturing Company.
P. C. Holmes & Company.
Wm. D. Warner.
H. N. Bates & Company.
Locke Brothers.
Park Manufacturing Company.
Mason Regulator Company.
Akron Iron Company.
Chase Turbine Manufacturing Company.
Maddox Wire Belt Company.
Belknap Water Motor Company.
Tripp Manufacturing Company.
Boston Belting Company.
Automatic Time Stamp Company.
John Becker Manufacturing Company.
Chase Turbine Water Wheel Company.

THIRD AWARD—BRONZE MEDAL.

"C. & C." Electric Motor Company.
T. M. Foote Regulator Company.
American Tool and Machine Company.
Chase Turbine Manufacturing Company.
Belknap Water Motor Company.
Babcock & Wilcox Company.
Messenger Valve Company.
Rodney Hunt Machine Company.
Ellis Lubricating Company.
S. A. Woods Machine Company.
Narragansett Machine Company.
Whitall, Tatum & Company.
W. D. Warner.

FOURTH AWARD—DIPLOMA.

Mass. Pulsion Telephone (Acoustic) Company.
Wheeler Reflector Company.
Tripp Manufacturing Company.
Granular Metal Company.
Athol Machine Company.

SPECIAL DIPLOMA—GOLD MEDAL.

Ashton Valve Company.
Emerson Power Scale Company.
Hancock Inspirator Company.

SPECIAL DIPLOMA—SILVER MEDAL.

American Fire Alarm Company.
Berrenberg Vacuum Pump.
Mason Regulator Company.
Asbestos Packing Company.
American Tool and Machine Company.
Locke Brothers.
Park Manufacturing Company.

SPECIAL DIPLOMA—BRONZE MEDAL.

Mechanics' Iron Foundry Company.
Old Colony Machine Company.
B. S. Hale & Son.
Barclay Lubricator Company.

Mammoth Wire Rope.

The wire rope made by the Washburn Iron Manufacturing Company, Worcester, Mass., in 1890, for the Denver Tramway Company, Denver, Col., discounts the Glasgow cable. It is 5,280 fathoms, or six miles long, weighs 43½ tons and has more than 800,000 tons of crucible steel wire in its make up.

Open House at the Electric Club.

January 1, 1891, will be celebrated with "open house" at the Electric Club, 17 East Twenty-second street. Luncheon will be served and the Club's silver punch bowl will be set out. From 1 to 10 P. M., will New Year be celebrated.

It is evidently a poor place for the telephone in the land of the Arabs; they have no "hello" in their language. The nearest they can come to it is to throw a stone and hit a man in the back, and then ask him, as he turns around: "Does it please Heaven to give you good health this morning?" There are some unscientific people who say they would prefer the stone in the back to a wrestle with the telephone on some exasperating occasions.

GENERAL ELECTRICAL NOTES.

Chicago has nearly 1,000 miles of police and fire alarm telegraph wire.

C. F. Hoff contemplates putting in a telephone exchange in Tucson, Arizona, in the near future.

The Sunbeam Incandescent Lamp Company, Chicago, Ill., has filed a certificate setting forth an increase of capital stock from $30,000 to $100,000.

During the past two years the Postal Telegraph Company has built more than 4,000 miles of line and is now pushing rapidly towards New Orleans. As soon as that link is finished the system will extend from the Atlantic to the Pacific and from the Great Lakes to the Gulf of Mexico.

"Paterson, New Jersey, Illustrated," is the title of a handsome quarto volume sent us by Mr. J. F. Noonan, of that city. It is a historical sketch of the city, its industries and prominent men. The electrical features receive their merited prominence. A large number of well-executed half-tint illustrations embellish the book.

The Pennsylvania Railroad Company has made a contract with one of the Philadelphia electric light companies for lighting their station at Tacony, Pa., and for a light at each crossing over a length of about four miles of track, which is within the city limits. Each division superintendent of the road is now preparing plans for lighting all suburban divisions in the same way. The system is to be extended as rapidly as possible with ultimate end in view of having an electric light at every grade crossing.

The telephone exchanges of Tokio and Yokohama are nearly completed and will be put in operation by the beginning of the new year. The distance between these two cities is 18 miles, and subscribers are allowed to converse with other subscribers in either city without extra charge. The annual charge in Tokio is nearly $40 for each instrument, and in Yokohama nearly $35. At the public pay stations a charge of five cents is made for five minutes' conversation, if both subscribers are in the same city, but if a conversation is carried on between the two cities, a charge of 15 cents is made for each five minutes. In Tokio the number of subscribers at present enrolled is 135, including the government offices. In Yokohama only 12 have so far subscribed. At Tokio there are 16 pay stations and at Yokohama only one.

Baxter Motor Trial.

A trial of the Baxter motors was held in Baltimore, December 27. Quite a large number of people witnessed the tests, which were very successful. A full account will appear in our next issue.

FINANCIAL.

Closing quotations of electric stocks, from F. Z. Maguire & Co., Electrical Securities, 18 Wall street, N. Y., Saturday, December 27, 1890. New York, Boston and Washington. Pittsburgh closing December 26, 1890.

	BID.	ASKED.
NEW YORK.		
Western Union Telegraph Co.	74½	75¼
American Telegraph & Cable	88	88
Central and South American		
Mexican		215
Commercial Cable Co.	102½	103
Postal Telegraph Cable	39	41
Edison General Electric Co.	85	88
" " Deferred		
Consolidated Electric Light		
Edison Electric Illuminating Co.	70	
United States Electric Light	30	
North American Phonograph		35
BOSTON.		
Thomson-Houston Electric Co.	41	41¼
" " " Preferred	36	36½
" " " Series C.		11½
" " " Series D.	5¾	6
" " International Co.		
" Welding Co.		200
" European Welding Co.	50	60
Ft. Wayne Electric Co	10½	
TELEPHONE:		
American Bell	210	212
Erie	46¾	47
New England	49	
Mexican	65	
Tropical American		1¼
MISCELLANEOUS:		
Edison Phonograph Doll		2
WASHINGTON.		
Pennsylvania Telephone	25	35
Chesapeake and Potomac		72
American Graphophone	11⅝	12
United States Electric Light (Wash'ton)	135	145
Eckington and Soldiers' Home Electric Railway	58	60
Georgetown and Tennallytown	47	55
PITTSBURGH.		
Westinghouse Electric Mfg. Co.	13¼	13⅜

Telephonic News

*** Elmira, N. Y., uses 350 telephones.

*** A number of long distance telephone instruments have recently been set up in Erie, Penn.

*** Arthur Bertsch has been promoted from inspector at the Grand Rapids exchange to manager of the exchange at Ludington, Mich.

*** The Sunset Telephone and Telegraph Company has 616 telephones and about 700 miles of wire in use in Seattle and surrounding districts.

*** The New England Telephone and Telegraph Company has bridged Purchase street, near Pearl, for the purpose of running its cables over the roofs of the buildings to its new building on Milk street, Boston.

*** The Pittsburgh finance committee will recommend an appropriation of $20,000 for the purpose of paying the expenditure of placing the wires of the police, telephone and fire alarm service underground in all that portion of the city lying below Grant street.

*** At a special meeting of the New York and Vermont Telegraph and Telephone Company, held at Troy, N.Y., December 18th, 542 shares of stock being represented, it was unanimously voted to transfer the stock, franchise and all the property of the company to the Hudson River Telephone Company, and in consideration therefor the Hudson River Telephone Company will pay all liabilities of the New York and Vermont Telegraph and Telephone Company.

"Liar" by Telephone.

S. B. Miles, secretary of the Cincinnati Abstract Company, has got himself into a pile of trouble, says the Cincinnati *Commercial Gazette*.

Miles called up W. H. Adderly's drug store, on Mt. Auburn, by telephone at 3.30 one afternoon, and requested the proprietor to send a message to his house, 3 South Auburn Place. Mr. Adderly refused to comply with the request, suggesting that he first pay him for a message previously delivered. Some words were exchanged over the wire, and Adderly, it is claimed, called Miles a liar. Miles said he would come up after a while and make him take it back.

At 4 P. M. he put in an appearance and a fight ensued, both he and Adderly getting in a few licks. Then Miles stepped from the store, and as he met Officer Bernhardt, demanded Adderly's arrest. Bernhardt was of a different opinion and he took Miles in charge, escorting him to the Corryville Police Station. A 41 calibre bull-dog revolver was found in his possession. He was charged with carrying concealed weapons and assault and battery.

To Go Underground.

Now that the Bell Telephone Company has almost finished the new building at Tenth and Olive streets, it has turned its attention to the work of getting its wires underground. All of the officers of the company have repeatedly stated that they want to get their wires underground and the city officials believe they do. There is not the slightest difference of opinion anywhere on this point. The wires should go underground. That is settled. But when it comes to making arrangements the differences arise. Some of the municipal legislators think that, in return for the privilege of a conduit, the telephone company should allow the city to use the conduit for all the city wires. As these wires are an indefinite quantity, the telephone company objects. Then another legislator thinks that all the wires should go down together and puts a blockade in the way of the telephone plan. Then the telephone company demonstrates, by means of experts and otherwise, that telephone wires and electric light wires will not associate with each other, and that whenever they do get together trouble occurs. So that the situation eventually simplifies itself into just one thing. The Bell Telephone Company wants a franchise for a conduit which shall be used for the telephone wires and no others, and if the city legislators do not grant this, the Bell telephone wires will remain up in the air.—*St. Louis Dispatch.*

"Electrical Units of the Present and Future."

ADDRESS BY PROF. FRANCIS B. CROCKER, OF COLUMBIA COLLEGE, DECEMBER 18, 1890, BEFORE THE ELECTRIC CLUB, N. Y.

The subject of my lecture is, unfortunately, but necessarily, a dry and somewhat difficult one. My only excuse for presenting it to you is the fact that it is certainly a matter of fundamental importance, and also that it is one about which most electrical men are, to say the least, not perfectly and clearly informed. It is a matter which usually one has no opportunity to learn. When most of the men in the electrical profession obtained their education, they picked it up, so to speak, as there were no regular courses of electrical instruction. In picking up information it is usually very hard to get, and one is apt to postpone it. No time comes for sitting down and finding out how the electrical units were derived, what they mean, and how they are related to each other, etc., etc.

The complicated and unattractive condition of the subject of electric units is partly due to the fact that it is a growth, and partly due to the fact that it is naturally and inherently a heavy subject. If to-day a system of units were to be devised, it would probably not be the present one. But the best system that could be devised would be difficult and complicated.

The matter of electrical units and electrical measurements is precisely similar to all other measurements. What is true of electrical measurements is true of others; in fact, electrical measurements are derived directly from ordinary measurements. If we go back historically to the origin of the subject, we find that in ancient times men did not require exact measurements. Numerous facts were presented to the view then as now, but men were satisfied with rough ideas. For example, even at the present time we know a physical fact just as well whether we measure it or not. I know the existence of the Hudson River or the Capitol at Washington, just as well whether I measure it not. I think that is a point that is not generally realized—the fact that we may perfectly and clearly know a thing without measuring it, although physicists are apt to think that unless we measure it we know nothing about it. But as soon as we come to definite work, either in science or commerce, measurement is everything, and the mere existence of the thing is of little consequence compared with its value. For example, in the case of a steam engine, the whole question is whether it is one or twenty or a thousand horse-power. Its mere existence is not important, and no one would buy a steam engine, or think of considering a steam engine, except in the most careless way, without knowing its power. It depends on circumstances whether we need measure a thing or not.

To measure quantities of any kind some unit is needed. In the crude, ancient days that I referred to, the roughest kind of units were sufficient. The length of the king's foot, of a barleycorn, or the side of some temple, or a stone in a pyramid, or something of that sort, were quite good enough for a unit. In fact, nothing better was needed. But as soon as the exact sciences developed astronomy, mechanics and other branches of science, and when commerce became more important and definite, the necessity for some more exact unit arose. The rough units I refer to are not only rough, but they are arbitrary. They might just as well select some other king's foot or some other stone in the pyramid, instead of the particular one selected. The more exact requirements of advanced work at first only required definite standards Therefore, the standard yard and the standard quart were adopted, but they were arbitrary. Some person decided what they should be and they were carefully made and deposited in the national archives, and exact copies of those were made and sent around to various points, and they became in some cases the legal standards.

Standards can be adopted by custom or by law. Some of the standards in common use are legalized and some are not. One or more of our most common standards have not been legalized.

So far they had merely arbitrary units. The quart bore no relation to the yard; the yard bore no relation to the second, and neither of the three bore any simple relation to any other unit. That is to say, the fraction representing the relations between the two would have several decimal places. But nevertheless each was definite in itself. The standard yard was a definite length of metal and carefully preserved. Therefore, it was as exact as any unit can possibly be, but it had the disadvantage of having no simple relation to any other unit, and when we pass from yards to quarts and from quarts to pounds, etc., we have no convenient way of translating the quantities. We are obliged to use very awkward figures. What is needed is an *absolute system* in which the units bear exact and easily remembered relations to each other. That is the essence of what is called the absolute system. But it happens that an absolute unit is a very hard thing to obtain. It is impossible to look about and find a standard length that is derived from any source that is unquestionable. It is a matter of judgment and choice, and nothing seems to be very satisfactory for the purpose.

The waves of light would be one of the most definite and one of the most ideal sources of a system of units. Each particular point of the spectrum has a definite wave length, and it also has a definite wave rate. That would give us a unit of length and a unit of time, and from one single phenomenon we could get two units. But when the absolute system was established, wave length and wave rate were not understood; and if you will consider the thing for a moment, you will see that it is almost impossible to think of any absolute unit—anything that will be as true in Asia as it is in America, and also as true a thousand years hence as it is to-day. That is what an absolute system requires. They simply selected the best absolute unit they could get, and they were forced to take a unit based on the size of the earth. But this is not a good unit on account of the difficulty of measuring the earth. It is so large that it is extremely difficult to measure it. The first question in this system of absolute units is, What units have we got to determine? This is largely choice, and it so happens that if we fix a few units we fix all the others. The others can easily be derived. The three facts in nature which are supposed to be absolute, and that philosophers look upon as the three fundamental conditions of existence and thought, are time, space and matter. These three facts are supposed to be fundamental, and everything else is a combination of them. This may be true, or it may not be true; but so far as matter is concerned, it is a question whether there is such a thing at all. It is impossible to know of it directly. We only know of matter through force. For instance, when we take a brick—one of the most tangible things one can think of—the reason we know that it contains matter, or think that we know that it contains, is that it is rigid, which is entirely due to the force of cohesion of its particles. One can quibble about this forever as with most other metaphysical questions, and it really does not make much difference either way. The existence of matter may be somewhat questionable, but, of course, there is something there that we can call matter, and we know there is time and we know there is space.

Therefore, time, space and matter were selected as the fundamental quantities, and it was necessary to find a unit for each.

Taking space or length, which amounts to the same thing, as the first, they began by measuring the circumference of the earth, or, rather, a quarter of it—the earth's quadrant—which is the distance from the pole to the equator. Of course, the actual distance from the pole to the equator was not measured; they measured one degree of it, and calculated from that. These measurements were carried on with the utmost care. It took months and months of the most careful work to make them. The metal bars were laid on the ground perfectly horizontally. The temperature had to be carefully taken. The bars had to be exactly in contact, that is, just touching each other—not enough pressure to produce any strain. It would probably take days to travel a few hundred feet, and to travel 60 miles and make an exact measurement of that sort, and expect to come out within a few inches, would require exceedingly careful and protracted work. Unfortunately, an error was made that would not be of consequence in anything else, but in the case of a foundation of a system of units it amounts to something—about one one-hundredth of one per cent. Nevertheless, from that measurement the unit was determined. But the question arose, what fraction of the earth's quadrant to take as the unit. Of course, it must be a round number. A ten-millionth happens to be about equal to a yard. A one hundred-millionth would be too small—about four inches. One is a little too small and the other is too large a convenient unit of length. The foot, which is a very convenient unit of length, is between the two, but unfortunately the earth didn't lend itself to this system of units. They chose the larger one, and made the metre the standard of length. The metre is simply one ten-millionth of the earth's quadrant, as measured by the French authorities. They made exact copies of it and deposited it in Paris, which is the center in regard to metric matters, and the various national governments are supplied with exact copies of the standard. An exact copy was sent to the United States not much more than a year ago. It was opened by the President of the United States in the presence of the officers of the government, and was a matter of considerable importance.

Having the metre, the question was to get a unit of weight. The unit of weight may easily be gotten by cubing—that is, making a volume from the unit of length and filling it with water. But a cubic metre of water would, of course, be too large for a unit of weight, as it weighs about a ton, so a fraction of it was taken. Here again a choice was necessary. A cubic centimetre of water was selected and called the gramme. I think that was a great mistake, because a centimetre is a very small thing and has tended to bring the whole system of absolute units into disrepute. It seems so small that it is not worth considering. I think if they had taken the decimetre, the tenth of the metre, as the unit of length and the cubic decimetre of water as the unit of weight we should have very much better and more harmonious units. A metre is too large and a gramme too small. The unit of time has already been selected. The second is simply the ordinary second that is used in calculating time all over the world and is also a very small unit. Thus we obtain the three primordial standards of length, mass and time, and since, for scientific purposes, the centimetre is taken instead of the metre, we have the centimetre, gramme and second as the three fundamental units upon which is based the C. G. S. system of units. Theoretically, and probably practically, all units of every kind, present and future, can be derived from these three simple fundamental units, which we can all understand and know just how they were obtained and what their values are. The mechanical units are very easily derived from the fundamental units. To obtain velocity, we divide length by time, that is to say, we do the same as in any other case when we say so many miles per hour, so many feet per second, etc. Acceleration, of course, is the increase of velocity. That is to say, it is distance divided by time, which is velocity, and that divided by time again, because if we increase the velocity in a certain time, that is acceleration. Force is giving acceleration to a mass, which is the Newtonian principle of measuring force. Work is simply force multiplied by distance, which again is well known. To take one pound and lift it two feet requires two foot pounds, and so on. The electrical units are almost as easily derived, but the question is what to start with.

There are two fundamental laws of electricity. One is Coulomb's law, which applies to static electricity, and states that a certain charge of electricity attracts or repels another certain charge with a force directly proportional to the product of the quantities and inversely proportional to the square of the distance. In former times static electricity was very important. The old books were full of dolls with hair standing on end, pith-balls, etc. It happens now that static electricity does not amount to much. There is no force in it. A spark passes and that is the end of it. We need something more constant than that. So when electricity is to be used, it should be in the form of current which lasts. The fundamental law of the electric current is that of Ampere, which states that a current affects a magnet in proportion to the strengths of the magnet and of the current, the length of the wire, and inversely proportionally to the square of its distance from the magnet. As we can measure the length of the wire and the square of the distance, hence we can get the strength of the current. But this involves having magnetic units. Here are two bar magnets supposed to be exactly alike. If I bring the North poles together they repel each other; and if the magnets were delicately suspended on silk fibres, and brought within a unit's distance and the repulsion between them accurately measured by the torsion of the fibre or by balancing them against some other known force—a delicate spring—then I would find how many units of pole strength the magnet had. To get a unit magnetic field from this we say that a unit pole placed at a unit's distance produces a unit's strength of field. The field is the thing important in dynamo machines and many other practical cases.

To get a line of force, which, by the way, is the unit that is most used in practice, we produce unit field and take a unit's area of it, which is called line of force. It is to a certain extent arbitrary, but it is definite, nevertheless, and that is the line of force that we use so much. We read of it in text-books and even in the daily papers.

To return to measuring the current. We take a unit pole and when it has a unit of force exerted on it by unit length of a current at a unit's distance and a unit length, then it is a unit current. Thus we pass from the quadrant of the earth to the unit of the current by several simple steps, each one of which is easy to understand and each one of which is perfectly logical and follows directly from the previous one.

From current, which is, in my opinion, the fundamental unit of useful electricity, we obtain quantity of electricity. Quantity of electricity is simply the amount of electricity that flows in a unit current for a unit time. Now, electromotive force is about the most troublesome one of these units. It means the tendency for electricity to produce a current and do work. Therefore, electromotive force multiplied by quantity of electricity would give you the work. If I have a certain electromotive force and one unit of quantity I will have a certain work that will be measured by the electromotive force. It is exactly like steam. I can have

100 pounds pressure of steam and one cubic foot of steam, I will have a certain amount of work. If I have two cubic feet of steam at the same pressure I will get twice the work. Conversely, if I have 50 pounds pressure and two cubic feet, I will have the same amount of work, practically—a little less in the case of steam—as if I had 100 pounds pressure and one cubic foot. In other words, the product of the pressure or electromotive force by the quantity is the work. Therefore, to get the electromotive, divide the work by the quantity.

Ohm's law gives the resistance as equal to the electromotive force divided by the current, these last two being known. From here on the derivation of the rest of the units is a mere clerical matter. For example, taking capacity as the next unit, we find it equal to quantity divided by potential, that is, the unit of capacity will hold a unit quantity at a unit potential. Work, as I have already explained above, is equal to potential times quantity. Power is rate of work. Therefore, potential multiplied by current, quantity per second, is power.

We come now to self-induction.

Self-induction is somewhat unfamiliar, nevertheless, it is becoming important. Self-induction in telephone work, aerial, underground and submarine lines, dynamo armatures, dynamo field magnets, transformers and other alternating current apparatus, are all practical cases of self-induction. We should consider self-induction almost as much as resistance. We have not done so heretofore, but that is no reason why we should not in the future.

It happens that there are several ways of defining self-induction, but the best way, I think, is to consider it as a counter electromotive force. That is to say, when I send a telephone current through an electro-magnet the latter reacts against the current. When the current tries to go through, the magnet tries to oppose it. Therefore, the best way to define the unit self-induction is to say that it gives a unit counter electromotive force when there is a unit change of current in a unit time. The ordinary way, however, of deriving this unit is to multiply resistance by time. That seems to be an odd way to get it, but what it means is this: That self-induction is the apparent increase in resistance that we get when we try to pass a current through a circuit. If I put a current through the field magnet of a dynamo machine, it will take some time before it reaches its full strength. The magnet will resist the current very much more than the mere resistance of the wire, if it were stretched out in a straight line, due to the fact that it is formed in a coil around a piece of iron. But after the current has got flowing, so to speak, then self-induction ceases to exist. It only occurs when a change is taking place.

The absolute units have no names, they are simply designated as absolute units of electromotive force, resistance or quantity, as the case may be. This means that they are derived directly from the centimetre, gramme and second, and "dimensions" of units are mathematical ways of expressing how these fundamental quantities enter each unit. Some of them involve all three of these quantities, some involve two, and some only one. Take, for instance, area. Area is L square; that is, the square of the length; for example, a foot square is an area. Volume is L cube. Velocity is L divided by T. That is, it is L multiplied by T to the minus one power. This enables us to put them all on the same line for convenience.

We come now to the practical units. Every one of these absolute units, derived, as I said, are either so small or so big that they are not useful.

It was necessary to take a certain number of a fraction of an absolute unit. In the case of resistance they took such a number of absolute units in round numbers as would most nearly approach the Siemens unit which had been used before and it happened to be 10^9 absolute units, which means that a billion of these little bits of absolute units will make one ohm the practical unit of resistance, naming it after the discoverer of Ohm's law and establishing the precedent of naming all the electric units after distinguished electrical scientific men, which rule has been followed without exception to the last unit. They call 10^8, that is, 100,000,000 absolute units of electromotive force, a volt. That approximated most closely in round numbers to the Daniell cell which had previously been used as the unit of electromotive force. They selected the nearest units to the two units already in existence, and having fixed those, theoretical value of the ampere followed. It is one thing to select how many practical units you will have in one practical unit and it is another thing to determine it. The whole system could have been originated without making a single experiment. The ampere can be determined experimentally very much more easily than the volt or ohm, as I said, by balancing the effect of the current on the magnet with some known force. Now, it happens that we know the force of the earth's magnetism. It is not at all difficult to find out by suspending a magnet, determining its time of swing and moment of inertia. Having determined the earth's magnetism, all you have to do is to balance the current effect on a magnet with the earth's effect on it, and knowing the earth's effect we know the current's effect and, therefore, know the value of the current, which is the whole principle of a tangent galvanometer.

Thus the tangent galvanometer will give us the value of the current in absolute units and if we take 10^{-1} of these we get the value in amperes. This is because the volt is 10^8 and the ohm is 10^9. Therefore, dividing one by the other, in Ohm's law, we obtain 10^{-1}. Having arrived at the current absolutely, we can also determine how much metal a current will deposit. But we cannot calculate it absolutely, however; we must determine it. I have here the exact weight of silver that one ampere will deposit in one hour. It was carefully weighed by the Assay Department of the School of Mines, and it is right to the tenth of a milligramme and weighs 4.0248 grammes. The ampere is a unit that is easily determined. The volt and the ohm require laborious work of years, and the original ohm, as determined by the British Association committee, was about 1¼ per cent. wrong, which is a pretty bad mistake for a scientific measurement.

In making actual standards of these units, the volt is the most elusive one of all. The tangent galvanometer and the silver deposition give up the ampere pretty well, and for the ohm we have a definite coil. But the volt is dependent on standard cells containing chemicals that are very apt to change. They are compounds and they are apt to decompose or change in their composition.

It happens that the unit of capacity, the farad, is a very large unit and we have to take a millionth of it to get a working unit. The microfarad is the standard and it is a pretty good sized standard. It is equal to the capacity of two or three miles of the Atlantic cable. It would contain the same quantity of electricity as two or three miles of Atlantic cable, and it would take a thousand Atlantic cables to equal one farad in capacity. Therefore, you see that what is called the "practicable unit" of capacity is very unpracticable. The reason the farad is so large is that we have obliged ourselves to define units in terms of one volt, one coulomb, etc. Now, with static electricity, one volt is very small. Our ordinary static charges are 100,000 volts or more; for instance it takes about 100,000 volts to spark one inch.

Now a static spark to jump an inch is not a particularly large one. These, to take the volt to determine the unit of static capacity, make it necessary to have a tremendous capacity to hold our coulomb at that very low electrical pressure.

I would like to point out the fact that we have "absolute units" and "practical units," so called. I put both of these in quotation marks. Absolute units, as I have said, are not absolute, they are based on an arbitrary dimension of the earth incorrectly measured. Now, practical units in the same way, are not practical, because we have one, the farad, that is 1,000 times greater than the greatest practical capacity in existence. Therefore, I maintain that we must have a third system of units and that is the "working" units. You could call them "commercial," but the objection to that is that they are equally used in the laboratory as in commercial work. We use a microfarad in the laboratory the same as in the office of a telephone or cable company. Therefore, they are not, strictly speaking, commercial, but they are *working* in both cases. Sometimes the working units agree with the practical and sometimes they do not. The ampere, coulomb and volt are the same although in telegraphy we use the milliampere. Then we come to the ohm. That is, the ohm is right for most practical work, but for insulation tests we have to use a megohm. Nobody thinks of giving insulation tests except in megohms. Therefore, for that class of work, the working unit is the megohm and not what is called the practical unit.

When we come to the microfarad, there is no question. The practical unit ceases entirely to be practical, and we have to adopt the working unit which is almost infinitely different.

The watt is a convenient unit for a great many purposes, but when we use it for large work we use the kilowatt, which, by the way, is a good way of rating dynamos, because it is fairly near a horse-power.

Then we come down to the last of all—the henry, the new member of the family, and it is a question whether the working unit will be a henry or a millihenry. I did think of reducing the value of the henry to $\frac{1}{1000}$ of its value as given in the table; but it would have been a mistake, for the reason that, instead of having its value one second multiplied by one ohm, we would have its value a second multiplied by a thousandth of an ohm or a hundredth of an ohm. That would be destroying the simplicity and the harmony of this system—a feature which it certainly does possess. Every one of these units is derived from every other one in the simple ratio of one to one, and in no case is there any complex relationship of a thousandth or ten-thousandth or anything of that sort. You see that the coulomb is an ampere multiplied by a second, a volt is one ampere multiplied by an ohm, a farad is a coulomb divided by a volt. A joule is a volt multiplied by a coulomb, and a henry is a second multiplied by an ohm; and to make any one of them anything, would, I think, be a mistake, particularly as it would have been the only exception to the harmoniousness of the system.

Fortunately, the henry approximates a practical value. For example, a large Edison dynamo, shunt wound, will run up to one or more hundred henries. A telephone magnet will be between $\frac{1}{100}$ and $\frac{1}{10}$ of a henry. We could not expect that to be a very large value. An ordinary relay is several henries in value. A large induction coil is often 1,000 or more henries in value. Therefore, there is nothing preposterously small or large about the henry. It is about right. I have given in the last column of the table the actual or experimental value. That is, 4.025 grammes of silver per hour is the ampere. The volt is .926 of a Daniell cell. The legal ohm is 106 centimetres of mercury one square millimetre in cross section, etc. The unit of self-induction is equivalent to the length of the earth's quadrant. Thus we see that often starting with the earth's quadrant in this system of units, to obtain the fundamental units of length, and passing through all the mechanical units and the electric units, we finally get back to the earth's quadrant again. It is certainly quite remarkable and striking. It is a fact, nevertheless, that the unit self-induction is properly represented by a length equal to the earth's quadrant. In fact, it has been called the quadrant and was so called by the Paris Conference, which, I think, was a great unfairness to American electrical men, both living and dead, because certainly America's contributions to electrical science and industry have been fully equal to those of any other country, and if England has the farad, joule and watt, named in honor of her distinguished electrical scientists, if France has the coulomb and ampere, if Germany has got the ohm, and if Italy has got the volt, I think it is certainly not unreasonable for us on this side of the Atlantic to ask for one unit, to be named after the discoverer of self-induction, Joseph Henry.

In regard to future units, which the requirements of advanced work will soon necessitate, we need a unit of the strength of a magnetic field. We can express it as so many lines of force to the square centimetre, etc, but that is a very clumsy way. If we simply called it one Franklin, it would be very preferable to a long sentence. We all have in mind the naming of some electric unit after Franklin, but, unfortunately, Franklin is not identified with magnetic work. He is identified with electrostatic work, but all the electrostatic units have been named. But, perhaps, his name may be adopted. We shall certainly require within a short time a magnetic unit defining the number of lines of force, and we will speak of a field as so many units, and we will have a name for it; and when we use it everyone will know what we mean. The naming of a new unit and giving it its value and deciding what it shall be, are very difficult questions. An error might cause considerable trouble and loss of time and all sorts of bad results, whereas, the proper selection of a unit would greatly facilitate work.

This treatment of units is necessarily superficial, and all I have attempted to do is to show you the general derivation of them, starting the very first conception and coming to the present time and a little beyond. In fact, by giving you some inkling of what the probability of new units is.

Combination Fixtures.

The users of illuminants, where electric light and gas facilities are enjoyed, fully appreciate the enterprise and push of metal goods manufacturers in placing on the market a large and varied line of combination fixtures.

The accompanying illustration shows a new combination for electric lights and gas designed and manufactured by the Bradley & Hubbard Manufacturing Company, Meriden, Conn. This is only one of the many designs in combination fixtures manufactured by this well-known fixture house; yet it will afford a comprehensive idea of the handsome and artistic workmanship for which the company named has been justly celebrated for many years past.

TELEGRAPHIC

... The shed at Johnstown in which the newspaper and telegraph men had their headquarters just after the great flood, was burned last week.

.... Under the new management the Independent District Telegraph Company, of Butte, Montana, has become one of the permanent institutions of the city.

.... The Finance Committee of the Pittsburgh City Council is considering the question of compelling the telegraph, telephone and electric light companies to put all their wires underground.

.... From April 1 to December 1 the St. Louis electric light, telephone and telegraph companies have erected 1,509 poles, replaced 253 poles, erected 295 guy poles and strung 80 miles of wire in the city. This does not include the poles erected by the street railroad companies.

.... "Development in the field of telegraphy will be along the line of simplicity in apparatus and operation," observes an inventor. "The telegraph is practically where it was 10 years ago. Men who are working away trying to invent things which complicate matters by the introduction of new and useless parts in apparatus and other men who are spoiling the wire by trying to increase its carrying capacity, are all on the wrong track. Simplicity is what we want, must and will have."

.... At a meeting of the directors of the San Francisco Board of Trade, held recently, resolutions were adopted in harmony with those recently passed by the Chamber of Commerce, requesting the California representatives in Congress to give their best efforts and energy toward securing the passage of an act authorizing a survey to be made for a trans-Pacific submarine cable route, and for subsequent legislation encouraging the formation of such a cable company. The resolutions further recite that the entire business and trade of the Pacific coast would be greatly stimulated and benefitted by the construction of a cable to the Hawaiian Islands, Samoa, New Zealand and the Australian Colonies.

The Operator's Fault, Of Course.

Many have been the laughable mistakes made by telegraph operators in transmitting messages, but it is seldom that one is recorded so amusing in its consequences as occurred in the Summer to a gentleman of this city.

He was spending his vacation at the shore. A dance was to be given one evening, and as Mr. —— expected his brother down from this city to attend the festivities, he bethought himself of the excellent plan of sending to him for some flowers, which are always acceptable to the young ladies on such occasions.

The scheme was no sooner conceived than it was put into execution. The telegraph office was sought, and the following message was ordered and directed to Mr. ——'s brother in Hartford:

"Bring three dozen Bon Silene roses."

With a tranquil mind and a happy heart Mr. —— awaited the simultaneous arrival of his brother, the roses and the eventful evening. But meanwhile the telegraph operator had got in his work, either at one end of the line or the other, and so far no one was the wiser.

Mr. ——'s plans for the distribution of the roses were doubtless well settled, and he eagerly awaited his brother's arrival. At length the latter hove in sight; but, goodness, gracious! what was the matter with him? He was loaded down with bundles, and out of his pockets peeped still others. In fact, it seemed to be only with difficulty that he could get along at all, so weighted down was he with the mysterious packages.

After partially recovering from his surprise, Mr. —— demanded to know what in the world his brother was sweating at. The latter, as soon as he had breath enough, demanded in his turn, in an injured tone of voice, to know why he had sent for so many. "I brought all I could," he added, "and that was two dozen and a half."

"So many what?" returned Mr. ——. "What have you got there, any way?"

The brother's suspicions began to be aroused and he said nothing, but drew forth the telegram which he had received:

"Bring three dozen beers sub rosa."—*Hartford Courant.*

* * The New York State Railway Commissioners granted and then withdrew their permission for electric cars operated on the overhead system to cross a suspension bridge at Binghamton. In view of the fact that vibrations caused by an electric car are less, if anything, than those caused by a horse car, such a discrimination seems arbitrary and unjust.

An Austrian Electric Railway.

A cablegram from Vienna, dated December 22, reads as follows: "It is announced that a company is about to be organized here, with a capital of 38,000,000 florins, for the construction of an electric railway between Vienna and Buda-Pesth, a distance of 250 kilometres. It has hitherto taken four hours and a half to make the journey, but it is expected that travelers by the proposed road will do it in two and a half."

The Money Market and the Manufacturers.

But for the splendid condition of the manufacturing interest there is little reason to doubt that during the past two months this country would have passed through a good-sized financial panic. Most of the elements necessary for such an upheaval have been at hand. The money market has been feverish, confidence in Wall street has been lacking, and big speculators have been getting in their work. Against all these disturbing features the great manufacturing interests of the country have stood like a solid wall. It is only those interests that depend upon an ever-fluctuating Wall street basis that have suffered seriously in the recent attempt at a panic. The solid manufacturing institutions of the country standing firmly on their own foundations — uninfluenced by speculative features—have saved the country from a misfortune. Wages have been paid and expended, and the little ripple that a few men can make has hardly been felt.—*American Machinist.*

Acknowledging the Gift.

We have received from the American Electrical Works, Providence, a square pasteboard on which is well printed in red and black inks, the following:

Christmas, 1890.—At this season of gift making and general good feeling we want to contribute our share to the festivities, and beg your acceptance of this slight token. Not knowing your personal tastes, and fearing duplicates of gifts, we send coin (legal tender), and urge you to spend it freely for whatever your inclination dictates, whether for art, insulated wires or tutti frutti. Gratify your wants fully; let pleasure have her sway; but avoid foolish extravagance, remembering that "a penny saved is a penny got."

Wishing you a merry Christmas and the happiest of New Years, we are,

Joyfully yours,

AMERICAN ELECTRICAL WORKS,
Providence, R. I.

In the upper left-hand corner is attached a little envelope marked "Token," sealed with sealing wax. Breaking the seal a bright, new, 1890 penny is disclosed. This is an extremely novel and tasteful Christmas card. In these stringent times, however, none but such prosperous firms as the American Electrical Works have the cents to make gifts.

A Dead Poet's Voice.

Yesterday was the first anniversary of the death of Robert Browning, "the writer of lays," as he once dubbed himself. Yesterday the anniversary was celebrated in England by several friends, and back from the portals of the distant and dim land of shades comes the loved and well-remembered voice preserved by the magician of Menlo Park.

It was on the 6th of April, 1889, that Miss Ferguson, at the studio of Mr. Rudolph Lehmann, succeeded in persuading Browning to speak into a phonograph, and it was at the Edison House, Northumberland avenue, that the experiment was made yesterday.

The poet's voice was heard in the tones that were so characteristic of him, and which were so well known and so well remembered by every one who was present. The lines he spoke into the instrument were a portion of his own poem: "How They Brought the Good News from Ghent to Aix."—*Philadelphia Times.*

BRIDGEPORT, CONN.

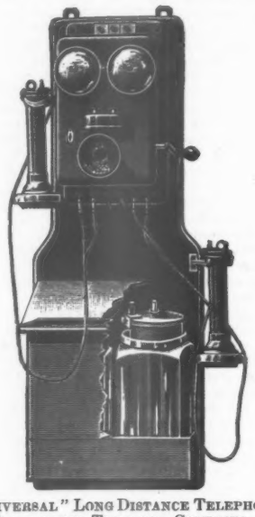
It is a Settled Fact that the street cars in Bridgeport are to be propelled with electricity at no distant day. From authentic sources I have learned that "a number of capitalists from Rochester, N. Y., recently purchased the franchise and other rights and property of the Bridgeport Street Railway Company, for which $350,000 was paid." These capitalists intend to equip the principal car lines with the single trolley system of the Thomson-Houston Electric Company; Main street and two other thoroughfares will be double-tracked—instead of single as heretofore—and all the cars of the various lines will be centered at the Union Depot. Work on the proposed changes is to be commenced at once and the electric system will be completed as soon as practicable; probably about May 1.

The Bridgeport Tool and Machine Company is one of the busiest enterprises in the city named. Its products will be found in nearly every thoroughly equipped manufacturing establishment in this country and Canada, more particularly at the factories where electric light machinery, electric power machines and electrical apparatus are made. Mr. E. P. Bullard, the proprietor of the Bridgeport Tool and Machine Company, is a close observer and fully understands the wants and requirements of the electrical manufacturing industries. The increasing demand for fine tools and machines for the manufacture of dynamos, generators and electrical apparatus, has compelled Mr. Bullard to enlarge his own manufacturing facilities. During the past quarter every inch of available space—the basement as well—has been utilized for additional machinery to insure the prompt filling of orders from the electrical manufacturing companies. Mr. Bullard appreciates the large electrical trade which has come to him almost, if not entirely, unsolicited, and he shows his appreciation by the use of electric light and electric power on his premises. The incandescent machine, which has a lighting capacity of 360 sixteen candle-power lights, derives its power from a 30 horse-power "Straight Line" engine, which is coupled direct to the dynamo by a coupling device of the Evans Friction Cone Company. The plant is completely equipped in every respect and is very compact. It is in a room only 12x16 feet, the entire equipment occupying about one-half the room. In an adjoining room is a 60 horse-power "Greene" engine, manufactured by the Pacific Iron Works, Bridgeport. This engine has been in use at Mr. Bullard's factory for more than 20 years, and scarcely any wear or tear is perceptible to even a careful observer. Mr. Bullard has also surrounded himself with gentlemanly and courteous assistants who make visitors at the factory feel at home. W. I. B.

December 20th.

Long Distance Telephones for the Export Trade.

Besides the exclusive right to export American Bell telephones, Blake transmitters and magneto call bells, which this company has enjoyed for ten years, the Tropical American Telephone Company has recently secured the exclusive right to sell in South America, Central America, West Indies and Mexico, Berliner's universal long distance transmitters and telephone sets and has arranged with J. Berliner, of Hanover, to manufacture exclusively for it, Tropical American telephone sets, thereby saving the heavy and burdensome United States royalties which have hitherto been paid for instruments manufactured under United States patents.



"UNIVERSAL" LONG DISTANCE TELEPHONE SET OF THE TROPICAL COMPANY.

Our illustration shows the Berliner long distance instrument, large numbers of which are in use and being exported to the countries mentioned.

J. W. Nagle, the discharged Western Union operator, who last Summer fleeced San Francisco pool-rooms by tapping the racing wires, has been found guilty.

Engine Exhibit at the Mechanics' Fair, Boston.

The only exhibit of engines at the fair was made by Westinghouse, Church, Kerr & Company. Their principal space was located in the center of the building in such a position as to be visible from all the galleries. A partial view of the exhibit is shown in the engraving. A Roney stoker was erected and set in brick work to illustrate the exact nature of the smoke consuming furnace. It was impossible, in the nature of the case, to show the stoker in operation in the actual handling of coal. The engine, however, was connected up to the boilers, and the stoker was continuously operated, so that its manipulation and adjustment could be readily observed. The amount of coal fed and the degree of motion of the grates are under the control of the fireman, and can be varied at will while the stoker is running. A single hand-wheel and nut on the connecting bar varies the feed from nothing up to the maximum capacity of the furnace to burn it. In like manner, the throw of the grates can be varied to any extent. Power is furnished from a half horse-power engine, which is adequate to drive an entire battery of boilers.

This company also contracts for the installation of coal and ash handling machinery, and when so equipped, the firing of a plant becomes nearly as automatic as when natural gas is used. The business of mechanical stoking and coal handling is developing into extraordinary proportions, and Messrs. W., C., K. & Co. have recently purchased a large factory property near Chicago, where the stokers are manufactured, giving them a capacity of at least 1,000 horse-power per day. The company exhibited a very striking wood engraving of a two-story boiler house, containing some 8,000 horse-power, equipped with stokers and coal and ash conveyers in the sugar refinery of Claus Spreckels, at Philadelphia.

In the same space were exhibited a 45 horse-power Standard engine; a 35 horse-power Junior, and a 50 horse-power Junior compound engine. This latter engine does not show in the engraving. It is the latest type of engine produced by the company, and is designed for a very high fuel duty in connection with low first cost. The modifications of the design are essentially those of

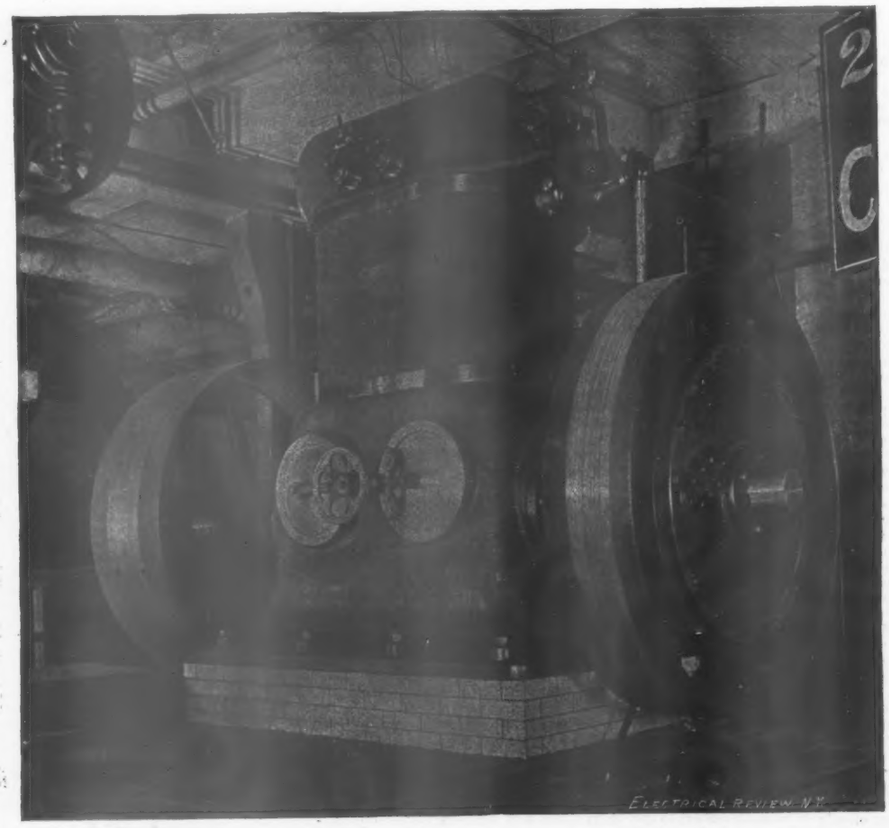


FIG. 1.—ENGINE EXHIBIT OF WESTINGHOUSE, CHURCH, KERR & COMPANY, AT THE MECHANICS' FAIR, BOSTON.

the well-known Junior automatic engine. The company, in connection with the Mather Electric Company, made a very striking exhibit, which is plainly shown in the engraving, consisting of a five horse-power engine and a dynamo carried, respectively, on and underneath a bracket which was bolted to a brick column at a height of eight feet above the floor. The dynamo was driven by an Evans friction device, and with the engine running at 500 revolutions, there was neither noise or vibration. This exhibit was well adapted to show the trying circumstances under which a self-contained engine will successfully operate.

Another interesting exhibit was a ten horse-power Standard engine dismembered and the working parts set up inside of a wooden skeleton, and driven at a slow speed by a belt from the line shaft, enabling the visitor to understand its working relations better than could be done by any description.

While the local office of the company was in the general space, the principal engine exhibit was necessarily located near the boilers and consisted of a 200 horse-power compound engine driving two large Mather dynamos, which performed the lighting services of the exhibition. An engraving of this engine is also given, the height of which, relative to the height of the ceiling can be well appreciated.

There were also exhibited in other parts of the building, a 75 horse-power standard engine driving a cold saw and a five horse-power Junior engine driving an ice machine. The former engine was subject to instantaneous changes of load, from practically its full power down to the friction of the engine itself. Under these circumstances the speed was found to vary but two revolutions in 300.

In some respects, the most interesting exhibit was the working example of the steam loop, in which the returning pipes were largely composed of glass, making visible the rapidity and power of the circulation and the return of the water. The steam loop could not be well included in the photograph and we, therefore, append a supplementary engraving (for which we are indebted to our esteemed contemporary, *Power-Steam*) of a small glass model, the operation of which can be understood from the following description:

The purpose of this loop is to return the water of condensation from a steam system to the boiler from a point either above or below the water level. In the model such a system is represented by the pipe leading from the steam dome of the boiler and discharging through the valve at the right. This, for example, might be the main steam pipe connecting an engine with the boiler. Just before being discharged in the model, the steam passes through a separator which enables the suction or "steam sweep" of the loop to collect the water which has been carried over with the steam or resulted from condensation. The loop commences with the riser at the right. The pipe forming this riser is, at proper height, turned toward the boiler with a slight inclination, and at the boiler again turned to form a drop leg communicating with the interior below the water line.

In order that steam may flow from one point to another, a preponderance of pressure is required at the starting point sufficient to overcome the frictional resistance to its movement. It follows, then, that at any point on a circuit of moving steam the pressure will be less than that in the boiler by an amount increasing with the distance from the boiler, measured by the flow and velocity of the movement.

As the riser is placed at the end of the system and the pressure is further reduced by the resistance of the loop itself, it follows that the point of lowest pressure will be in the drop leg. Were the pressure uniform throughout the system, the water would stand in this leg at the same level as in the boiler; but, having a lesser pressure above than below, when the stop valve between the boiler and drop leg is opened, the greater pressure in the boiler forces the water in the leg upward until the height of the column balances the difference in pressure. The top of this column forms a "dead end" at the point of lowest pressure, and toward it the circulation naturally sets, carrying with it the water of condensation, at first in the form of a spray or a thin film swept along the inner surface of the pipe, and afterwards, when the accumulation of water is sufficient, in the form of small slugs or pistons of water, which completely fill the pipe at intervals, traveling rapidly toward the dead end. This action is very plainly shown in the glass tubes of the model. As each slug is deposited on top of the column in the drop leg, it increases the weight of the column above that due to the difference in pressure at the top and bottom, and sufficient water enters the boiler by gravity to maintain the equilibrium.

The several engines exhibited by this company, being located at long distances from the boiler, were all protected by separators at the throttle valves with steam loops returning to the boilers. The visitor was enabled, therefore, to see the system in actual operation under very severe conditions and the interest in this new and valuable device was of marked character.

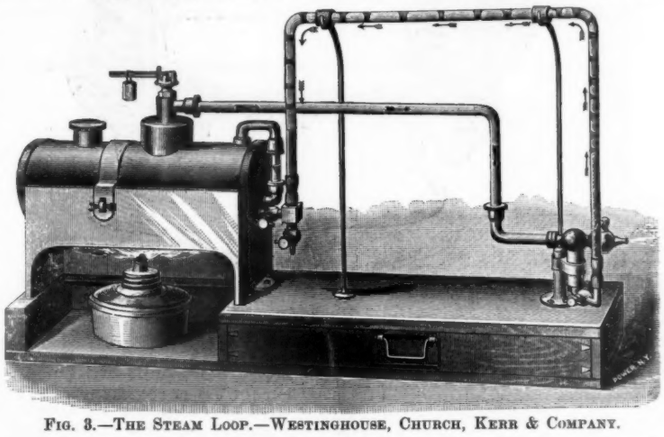


FIG. 3.—THE STEAM LOOP.—WESTINGHOUSE, CHURCH, KERR & COMPANY.

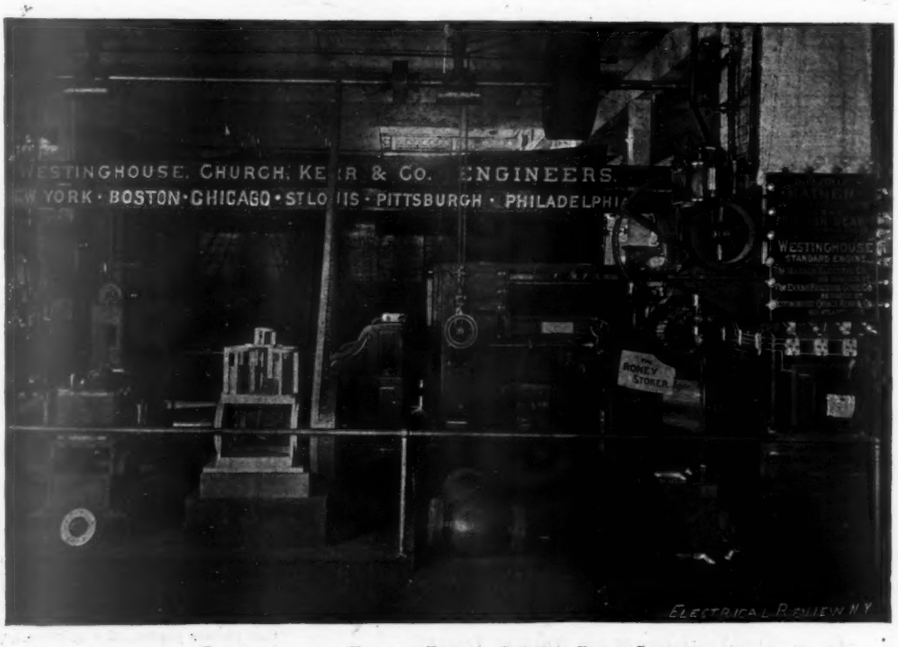

WESTINGHOUSE, CHURCH, KERR & CO. ENGINEERS.
NEW YORK · BOSTON · CHICAGO · ST LOUIS · PITTSBURGH · PHILADELPHIA
WESTINGHOUSE STANDARD ENGINE
RONEY STOKER
ELECTRICAL REVIEW N.Y.

FIG. 2.—ANOTHER VIEW OF EXHIBIT, SHOWING RONEY STOKER.

Snow and the Electric Roads.

The severe storms in Boston last week gave the West End Street Railway officials some valuable experience which they will doubtless profit by. Notwithstanding the heavy snow fall, only two or three of the main electric lines were crippled for a short time.

New Offices.

The Central Electric Company has presented itself with a new set of offices for a Christmas present. On account of the increase in its various departments, the company finds it necessary to have the business divided up so that each department will be in charge of some one person, who will give it exclusive attention. The president and secretary, under the new arrangement each have a private office, which is very neat and attractive, and will repay a visit from any one interested in electrical work, and who may happen to be in the city. The appearance of the salesroom is also vastly improved. Among the many large orders received the past week by the Central Electric Company, was one from Denver, Col., consisting of all kinds of electrical supplies including Okonite and Candee wire. The order complete filled five cars.

—— The Alton, Ill., Gas and Electric Light Company will sell its present electrical plant and invest $25,000 in a new one.

—— The Jamestown, N.Y., Electric Light Company's plant was destroyed by fire December 21. Loss estimated at $30,000.

—— In view of the stand taken by the Crawfordsville, Ind., council, the electric light company of that city has offered to make a reduction of 30 per cent. in present schedule prices if the city will not proceed with the declared purpose of establishing its own plant.

ELECTRIC LIGHT NEWS

—— There are 185 miles of electric light wire in Chicago.

—— There is some talk of putting in an electric light plant at Mayville, N. Y.

—— Thorntown, Ind., is seeking to establish an electric light plant.

—— It is reported that the southern district offices of the Edison General Electric Company will be removed from New Orleans to Atlanta, Ga.

—— The Citizen's Electric Light and Power Company, of Covington, Ky., has declared a dividend of four per cent. to all stockholders of record. The dividend is payable on the 10th of January.

—— The Brush Electric Company, of Cleveland, Ohio, has brought suit against the Marble City Electric Light and Power Company, of Rutland, Vt., for infringement on its double carbon arc lamp patent.

—— In the New Orleans city council, December 16th, the ordinance creating a board of electrical control for the purpose of regulating the erection of electric light poles, etc., came up and was defeated by a vote of 16 to 3.

—— Bids have been opened for lighting the streets and public buildings of Brooklyn for the year 1891, The two electric light companies, the Citizen's and the Municipal, each make the same offer per year, $182.50 per arc lamp.

—— An official of the Thomson-Houston Company is reported in the Boston *Globe* as follows: "Sales now average about $1,000,000 per month. For the week ending last Wednesday they were $265,000. We are selling now wholly for cash."

—— The notice of a reward of $20 for the arrest of persons guilty of breaking street lamps, offered by a Seattle, Wash., electric light company, has had a good effect. Although no arrests have been made, there has been a marked decrease in the number of broken lamps.

—— The chief feature of the work of the Nationalists before the Legislature this Winter will be an effort to obtain for cities and towns the right to manufacture and sell gas and electricity for lighting purposes. Last year a bill to this effect passed the House, but was defeated in the Senate.—*Boston Transcript.*

—— One of the most successful central station plants of incandescent electric lighting is the one established last Spring at Windsor Locks, Conn. The electric light company of that town commenced operations at that time with a 500 light dynamo of the Westinghouse alternating current system; since then the capacity of the plant has been increased twice and to-day the company is able to furnish more than four times the amount of lights of its original capacity. The Westinghouse Company is now engaged with the installation of a 750 light alternating current dynamo.

—— The Boston *Daily Advertiser*, in its issue of December 22d, contained the following special dispatch dated Providence, December, 21st: The rumor that the Armington & Sims Engine Company, of this city, was about to move its plant to St. Louis appears to have an authentic origination. Mr. Sims has just returned from St. Louis, where he has been looking up a site. He is satisfied with the Western city, and considers it more suitable than New England for his industry. He is quite enthusiastic about the advantages for securing material for the iron business in St. Louis, and also the business enterprise of the people of that section, but on account of the unsettled state of the money market at present, will not be likely to take active steps at once.

Double Trolley Improvements.

Mr. Frank Wheeler, of Meriden, Conn., has devoted a good portion of his time and considerable inventive ability to devising the improvements in double trolley systems shown herewith. In Fig. 1, a bar of wood supports two hangers having clips for supporting the two conducting wires. The two-wheeled trolley runs on these wires.

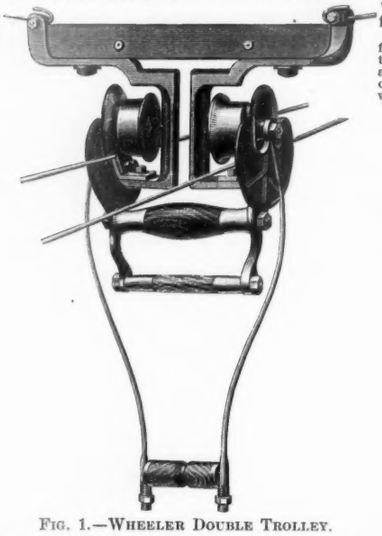


FIG. 1.—WHEELER DOUBLE TROLLEY.

The arms which depend from the wheel axles have insulating material between their lower ends and are the means of connection with the car motor. The trolley can only be removed from the conducting wires by pressing the latter together between two hangers and allowing them to spring up past the inner ends of the wheel axles. This trolley is designed to be especially valuable in mining installations.

A four-wheeled trolley is shown in Fig. 2. This is very similar to the one just described, but it is claimed that the use of four wheels gives a much steadier motion.

A switch for use with this trolley is shown in Fig. 3. Its main object is to avoid short-circuiting and yet make close contact when the ends of the switch track rods pass from one branch pair of conductors to the other. By making the ends of the rods to rise and then fall in their travel across, this end is accomplished.

Fig. 4 shows a crossing or turn-table switch for use with this trolley. A frame carries the separated hangers fixed in the required relative positions. A cord passing over pulleys is used to operate an arm which causes the table to revolve. Where one cord is used a spring imparts the reverse motion.

Mr. Wheeler's devices are in successful operation in a number of complicated installations and are giving entire satisfaction.

A Newark Power Station.

On page 233 we present an illustration of the new power house of the Newark, N. J., Rapid Transit Railway. Steam is supplied by four Erie boilers of 150 horse-power each. Two Corliss engines of 250 horse-power each, built by Hewes & Phillips, of Newark, drive a line of shafting from which power is transmitted to the generators by Page belting. There are four Edison generators of 80,000 watts capacity each and one of 40,000 watts capacity. The switchboard is a handsome affair of slate bound with brass.

The road equipment consists of 16 handsome vestibuled cars built by A. L. Rogers & Company, New York. Each car is equipped with two 15 horse-power Sprague motors. Some pretty steep grades and sharp curves are encountered on the line, but all are taken with ease. As near as could be judged, the car speed averaged about eight miles per hour. The overhead center pole construction is used. The cars are of a dark green-brown color, trimmed in gold, and make a very handsome appearance as they skim up and down the line.

The Improved Gramophone.

BY EMILE BERLINER, BEFORE THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, DECEMBER 16, 1890.

It might seem strange to you at first that I should commence discussing the gramophone by talking about induction; but I would like to refer to a small portion of a paper which I read before the Franklin Institute, in 1888, on the gramophone, when it was first shown, in which occurs the following:

"In my telephonic studies I had become familiar with all the causes influencing the transmission and reproduction of the voice, and what had at all times struck me as forcibly as anything in telephonic phenomena was the fact that the self-induction of long iron wires or of polarized electro-magnets acted so detrimentally upon the articulation. Electric resistance alone would simply have weakened the sound, but self-induction meant retardation and thus distortion of the transmitted waves which varied in length and amplitude."

And further on:

"In considering such and other facts it became evident to me that if such delicate energy as the voice, subdivided into, maybe, several hundred waves, should indent or engrave itself into a solid body, it needed but very slight mechanical resistance to modify considerably the character of the sound vibrations, for what self-induction is to the telephone circuit, the variable resistance which impressible material offers to indentation or engraving at various depths is to the phonograph record sheet. Neither is proportional in direct ratio to the expended energy, and must give cause, aside from a reduction in size of the sound characters, also to a distortion of the same."

And that brings me right to the subject of this evening, and I start by further explaining here, that those remarks had reference to the fact that in the phonograph it was impossible to make a loud reproduction which at the same time would be natural in tone. So long as you confine yourself to the small telephone voice the sound is natural and very satisfactory, but so soon as you attempt to indent a greater depth the waves are distorted and the sound becomes unnatural. In the gramophone, as you will further on see, and I suppose you are perfectly familiar with the principle, there is no indenting and no engraving, but there is a constant resistance, that of the light pressure of an elastic blade on a flat surface, or on a cylinder, if you please, but whatever resistance there may be in it is constant. And that is the principal difference, speaking scientifically, between the phonograph and the gramophone, that in one you have a variable resistance, in the other a constant resistance.

In May, 1888, before a meeting of the Franklin Institute, in Philadelphia, I showed publicly for the first time, how sound-records could be etched in metal, and how the original sound could again be made audible from such etchings. What I there demonstrated was of necessity crude in its effects, because embodied in the invention were a number of entirely new processes, new principles of construction and an art which dealt with motions infinitesimally small, the effects of which cannot altogether be either seen or measured; all of which was brought to bear on the single problem of fixing forever and with as much resemblance to nature as possible, both in loudness and quality, the sounds of instruments, of noises of all kinds, and of that delicate and subtle form of energy, called the human voice.

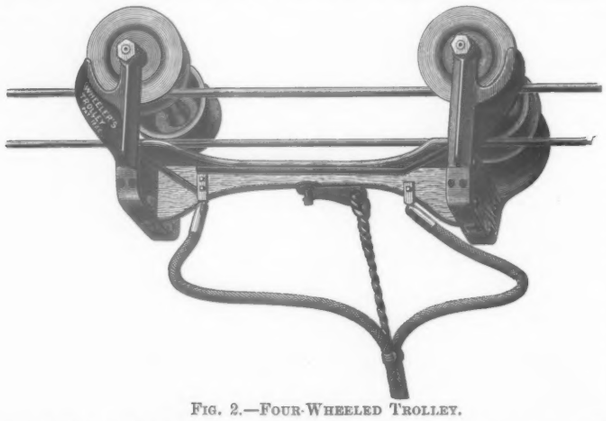


FIG. 2.—FOUR-WHEELED TROLLEY.

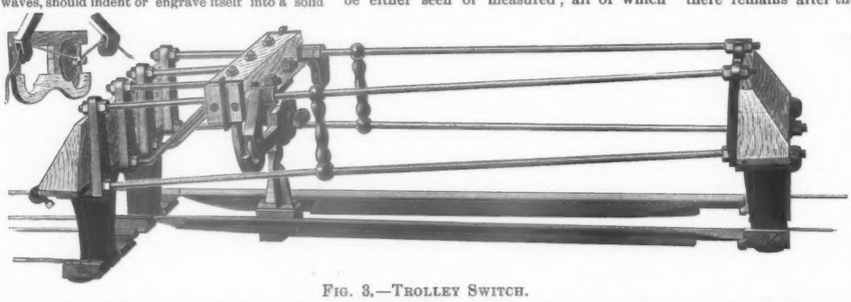


FIG. 3.—TROLLEY SWITCH.

FIG. 4.—TURN-TABLE SWITCH FOR WHEELER TROLLEY.

At the same meeting, I read a lengthy paper dealing with the history of the twin arts, that of transmitting sound electrically, and that of recording and reproducing the same mechanically. That the development of both arts occurred as I then showed, in parallel steps, is not the only excuse for bringing talking-machines before electrical societies.

In the gramophone, at least, there occur materials and processes, which, partly or wholly electrical, comprise terms familiar to every electrical engineer. Zinc, acid, bichromate of potash, diaphragms, dampers, electrotyping, all these play their part in the technique of the gramophone, not to speak of the possibility of applying electric motors to drive the machines, and of using the electric current for rapid etching.

The science of electricity almost began with immersing zinc in acid, but crude force alone is thereby set free, while in the gramophone, the action of the acid on the metal is so curbed and regulated that under it the zinc becomes a picture of sound-waves which, though slumbering in a bed of hard metal, is ready at any time, even centuries hence, to burst forth into the soft cadenzas of word and song, the ripple of laughter, the strains of martial music, as well as the melancholy and imploring drag of the organ-grinder's tuneful melody.

The hydrogen which would otherwise be set free, is neutralized by the well-known depolarizer, chromic acid, and the carrier of the recorded sound-waves is so perfectly and yet so delicately insulated from the action of the acid, that a spiral of sound undulations 600 feet in length, could, without difficulty, be traced and etched on an eight-inch disk, and would represent when reproduced a continuous conversation lasting seven minutes; all this automatically, and with far greater facility than is possible in making a photograph picture.

In the art of etching, that which insulates the metal from the action of the acid is called an etching-ground, and in the gramophone, this etching-ground is a very delicate fatty film, deposited from the fluid state upon the metal surface. This fluid is made as follows: Into a bottle containing one quart of gasoline, benzine, or petroleum ether, are put two ounces of scraped, dark yellow beeswax, and allowed to digest, with occasional stirring, for several hours. We shall then find a clear yellow fluid on the top, and a white cheese-like precipitate at the bottom. The clear fluid is decanted or syphoned off into another bottle, and diluted with the same quantity of gasoline.

When this fluid is poured on an absolutely clean and slightly warmed metal surface, there remains after the gasoline has evaporated, a delicate fatty film, very porous, and so thin that it shines in iridescent colors. It is somewhat tenacious to the touch, but loses its resistance in a remarkable degree when alcohol is poured over it. As soon, however, as the alcohol is washed off with water, the film assumes again its tenacious quality with but very small loss in weight, due to its dissolving slightly in alcohol.

As this etching-ground forms one of the keys to the whole gramophonic art, I will illustrate its qualities by the following experiment:

I have here a strip of zinc, over which the fatty film above described has been deposited from the solution of waxy fat. I have here also a piece of blotting paper, and with its edge touching the film, I now draw several cross-lines on the zinc. Next, I pour alcohol over it and draw a single line over the length of the strip, taking care to touch the surface as lightly as possible. I now wash off the alcohol and plunge the strip into this glass containing a solution of chromic acid, and you will presently see the long line appearing as a dark streak on the zinc, while the cross-lines appear less marked and more reluctantly, showing that the film offered less resistance under the alcohol than without it.

When, after about 10 minutes, we take the strip out, we will find under a magnifying glass that the track of each cotton fibre of which the blotting paper consists is sharply etched into the zinc; the rest of the metal has remained entirely untouched. Such is the nature of the etching ground used in the gramophone for etching sound records.

I will now illustrate how such records are produced, but I would like first to recapitulate briefly what I dealt with at length before the Franklin Institute relating to the history of the art of making sound records of the human voice. That dates back to the year 1857, when Leon Scott patented his phonautograph, which is described in every book on physical science. It consisted, as you see on that picture yonder, of a cylinder mounted on a screw and turned by hand, a barrel-shaped mouth-piece, a diaphragm provided with a damping device, a flexible stylus attached to the center of the diaphragm and means for adjusting the position of stylus and record sheet to each other. The cylinder is covered with paper smoked with an oily flame, after which the stylus is so adjusted that it presses lightly on the smoked surface. When the cylinder is now revolved,

the stylus traces a spiral line on the paper, and when at the same time sound enters the barrel, the diaphragm will vibrate and the spiral line assume an undulatory form, according to the nature and pitch of the sound emitted.

Such tracings of sound are called "phonautograms," but since I have found that those published as having been made by the phonautograph are not true curves of the sounds they were supposed to represent, I have here some which are more correct, and drawn from gramophone records, representing some of the more prominent vowels. The waves are complex in character, and between 75 to 150 of these compound waves follow each other per second in the pitch of the ordinary human voice; all of which is well known and described in the chapters on sound of physical science.

In the Spring of 1877, and following in the wake of the invention of the speaking telephone, it occurred to Charles Cros, of Paris, that if such sound-tracings could be engraved, for instance, by the photo-engraving method, and the stylus be then permitted to travel again in the groove or track of these engraved record lines, by revolving the cylinder past the stylus, the original sound would be reproduced. This was about six months before the invention of the phonograph, but the technical difficulties which appear in the attempt to bring about the desired result, must have seemed too great to Cros; or he must have gotten discouraged when, later on, seeing the apparently simpler method of the phonograph. At any rate, it appears that he never accomplished what he had conceived with such acute logic, and his paper on the subject (which can be found in the *Comptes Rendus*) was barely noticed and quickly forgotten.

It was not until after the granting of the patent for the gramophone, that I happened to see a reference to it, and searching the *Comptes Rendus*, found the article mentioned, which I then translated and embodied *verbatim* in my paper before the Franklin Institute. While, however, Cros had a correct conception of the general principle of a talking machine, it would have required considerable modification of the rules taught by physical science, which were then at his command, to obtain practical results; but I will illustrate what he meant with this model built on the principle of the gramophone.

Here is a drum-head of oil-cloth, and across it and pivoted at the top, is an arm or stylus, which is connected to the center of the drum, and, therefore, moves with the latter. The free end of the arm extends beyond the periphery of the drum and carries a brush dipped in ink.

If I now pass a strip of paper underneath the brush and at the same time move the drum regularly to and fro, an undulatory line of regular character will be drawn on the paper. If I repeat the experiment, but more irregularly or jerky, the motions of the drum appear marked down as a jerky irregular line.

I now replace the brush by a hard stick and permit it to travel in an undulatory groove engraved in a strip of wood, which strip I draw underneath the stick, and you will see by the reflection of light on the oil-cloth drum-head that it is moved to and fro by the engraved wave-line, and if these motions should occur rapidly enough, a sound would be emitted by the drum.

This illustrates the general principle of the gramophone. It is, however, in the method of engraving the sound records that the gramophone departs materially from previous methods, and this I will now show you. Here is a disk of ordinary zinc, such as you can buy in every tin shop; it has been polished, carefully cleaned and has then been coated with our fatty film. I now place the zinc on the turn-table of the gramophone recorder. The turn-table is revolved by a friction wheel underneath and connects through gearing with a screw, which propels a carriage across the turn-table at a slow rate of progression. On this carriage is mounted the recorder proper, namely, a mica diaphragm, across which lies a spring, fastened above and carrying at the lower free end a slender metallic blade, bent downwards slightly, and tipped with iridium, like a gold pen. This blade I now bring down upon the fatty film until it is straightened.

Mounted near the turn-table is a bottle containing alcohol, from which a spout extends to the center of the turn-table, dropping the fluid upon the fatty film, on which I first pour some of it so as to soak it.

If I now revolve the turn-table, the blade or pen marks a plain line into the fatty film, and as the iridium tip is kept free from the dust-fibres, which are continually floating about in the air, and upon the film also, by the presence of the alcohol, the line in proper light appears as a fine silvery streak in the dull fatty surface, showing that the metal is being laid bare by the iridium tip.

If, now, sound enters the tube leading to the diaphragm, the latter will vibrate and the line will assume the undulatory form of sound-waves, as before explained.

The gearing of the machine is at present set so that 72 lines are drawn to the inch; but for the ordinary conversational tone, the lines might be twice as close together, without the waves touching. The turn-table revolves at the rate of about 60 times a minute for this size of disk, and if they are smaller, the velocity must be increased, so as not to crowd the waves too close upon one another.

The talking being done, I lift the disk from the machine and dip it in water, which washes off the alcohol, and there is now visible a band of silvery lines in the fatty film. I may now write the date in the central portion of the disk, and I press the patent-stamp on it, or add any other remark or signature, all of which will be subsequently etched in, and I may now plunge the disk into the bath of chromic acid. Immediately, the acid attacks the zinc in the lines, and a dark cloud forms over the record, due to the formation of a subchromate of zinc.

While the disk is being etched, let me now turn to the reproducing machine. The principal part is again a turn-table moved by a friction wheel underneath. Above it is an arm pivoted with one end upon a standard having a double or universal motion, and the other end carries the producer proper, namely, a diaphragm of mica, vulcanite fibre, rubber, or ivory, across which is fixed at its upper end, a stiff spring connected by a post to the center of the diaphragm, its free end extending beyond the periphery, and carrying a small steel needle which may easily be taken out and replaced when necessary. This pivoted arm is the invention of Mr. Werner Suess, of Washington.

One of the mechanical curiosities of the gramophone is the fact that the etched record itself is the screw which propels the diaphragm from periphery to center, for the stylus resting in the groove by gravity or slight pressure, not only is vibrated, but following it and being able to move freely, is led along to the center and to the end of the etched record automatically. This places the gramophone reproducer in the realm of extreme simplicity, and beyond the necessity of repair under ordinary everyday conditions.

The possibilities of extending the gramophonic principle, are perhaps more noteworthy than its present development. The disks can be easily duplicated, and at the first exhibition in Philadelphia, I showed an electrotype of a 12-inch disk which sounded precisely like the original. Since then, I have also succeeded in making talking copies by pressing a matrix into molten glass, but the matrix being of copper, the glass used to stick to the form and warped the glass copy. I am assured, however, that whenever I shall furnish a steel matrix, the perfect copying in glass will be entirely feasible. That such steel matrices can be made, is not doubted by those familiar with the art of transferring lines and then etching the same.

We may then have dinner sets, the dessert plates of which have gramophone records pressed in them, and which will furnish the after-dinner entertainment when the repast is over. Gramophone plaques with the voices of eminent people will adorn our parlors and libraries.

Very successful copies have been made in celluloid from electrotype matrices, and such celluloid copies are particularly free from all frictional noise, provided the celluloid is pressed hard and of well-seasoned material. Gramophone records have been printed, and such prints have been photo-engraved, and the copy thus obtained sounded precisely like the original.

Successful copies have been made by letting one disk sing or talk to another one by coupling the recorder to the reproducer by a tube and turning both simultaneously. In fact this whole matter of duplicating disks is a department in itself, and would require a separate evening to do it full justice.

I have to dwell on these facts, in order to ask your indulgence in not having been able for this evening to cover the important field of copying records—but I have also been disappointed in not receiving a number of celluloid disks, such as are now being made in Germany.

The important subject of good articulation has ever been kept in the foreground, and this is now in so satisfactory a shape that I am carrying on a vocal correspondence with my friends in Europe, by means of small gramophone disks, which can be mailed in a good-sized letter envelope.

Foremost among the feats which the gramophone can perform is the absolute certainty with which it enables people to recognize the speaker's voice, and I could cite a number of instances where persons have been made happy by hearing and recognizing the voices of loved ones whom they had not seen in years, and the owners of which were thousands of miles away.

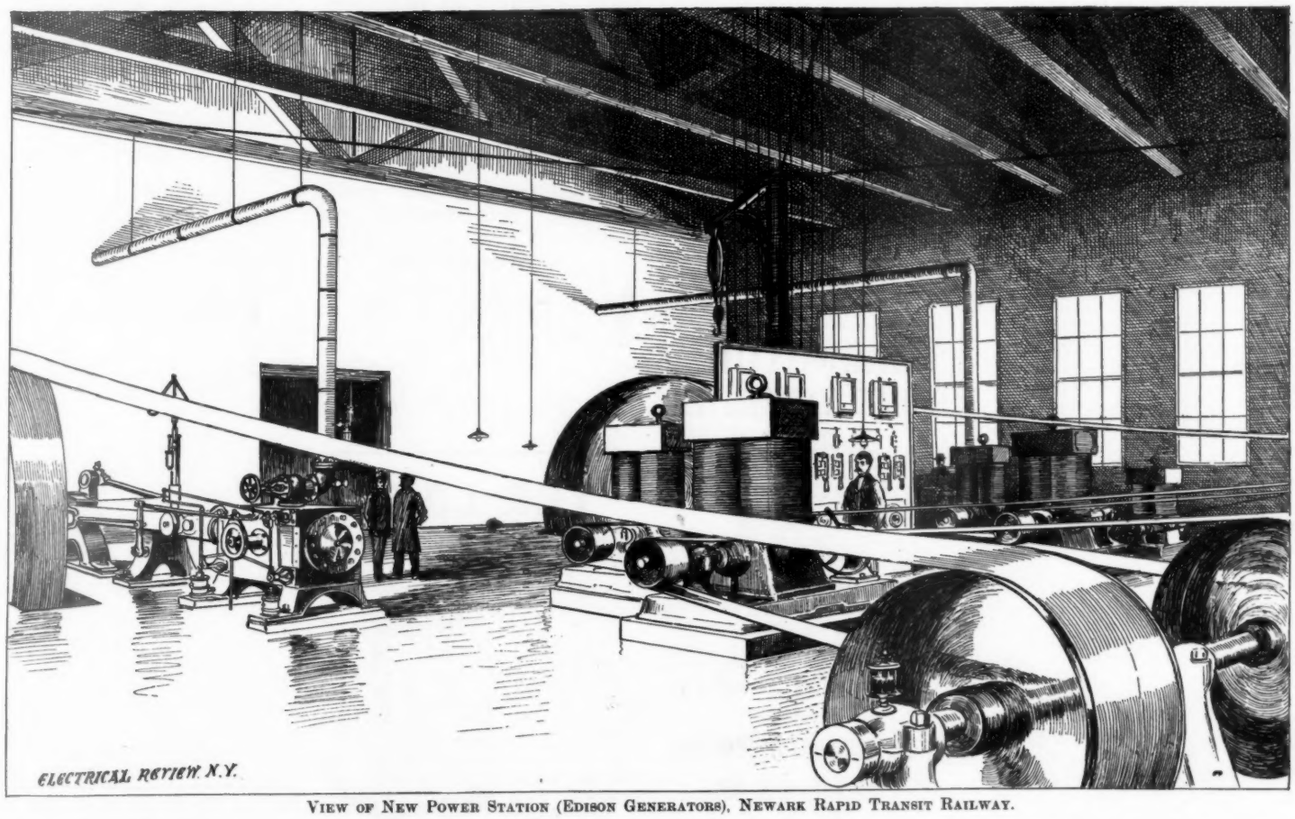
This whole art is now manipulated with great certainty, and can be learned much easier than the art of photography. Yet, favorably as I believe the gramophone compares with other talking machines, it has barely entered upon the possibilities which lie dormant within its principles, only awaiting the touch of investigation to yield new and important scientific data.

Its advantages at the present time can be summed up as follows:

1. The records are durable, and require a minimum of space for storing.
2. Recognition is perfect.
3. The mechanism of the reproducing machine is a model of simplicity.
4. The records can be printed, and from such prints copies can be made which will sound like the original.
5. The quality of the sounds does not become impaired with increasing loudness.
6. The making of copies is possible by several well known methods in existing arts.

Lastly, I ought to again refer to the possibilities of enlarging the record lines by the photo-engraving process, and thereby rendering the sounds with increased loudness.

Whatever the art of gramophony represents at the present time does not consist of accidental results, but the principles and the errors to be avoided are well known and established, and not a month passes but that new light is thrown on hitherto obscure sections of manipulation, and after three years of work, in which numberless sources of error have been eliminated, the art of etching records has lost none of its attraction, rather fascinating the mind by presenting the possibility of unlimited applications in the service and for the pleasure of mankind.



VIEW OF NEW POWER STATION (EDISON GENERATORS), NEWARK RAPID TRANSIT RAILWAY.

KINDRED INTERESTS

The Thomson-Houston Electric Light Company, of Philadelphia, on December 25, removed its offices and factory to 509 Arch street.

The H. E. Swift Manufacturing Company, 34 Oliver street, Boston, report large sales of their "S S" socket. They are many thousands behind their orders for this device. A new socket will shortly be introduced by this firm.

The Thomson-Houston Electric Company, through the Western Isolated Lighting Department, reports recent sales as follows: National Distilling Company, Milwaukee, 100 light incandescent plant; St. Louis Railroad Company, St. Louis, plant for cable power house, 200 lights capacity. This latter is in addition to a 400 light plant sold the same company a short time since.

Merchant & Company, dealers in metals, have sent us, from their Philadelphia office, a copy of their latest advertising book. It is called "A Midsummer Night's Dream: Being a Somnambulistic Ramble With Merchant & Company and Their Friends the Brownies." It is illustrated with a large number of half-tint engravings made from wash drawings. The brownies, made famous by the drawings of Palmer Cox, are here cleverly used to bring into prominence the various points in the manufacture and use of the large list of metallic supplies kept by this old and well known house. Altogether it is one of the most charming and artistic advertising novelties we have ever seen.

Joseph Ketchum & Company, 46 to 48 Lexington avenue, Brooklyn, have recently introduced a new insulating compound and tape, which will undoubtedly attract considerable attention. The compound possesses, it is claimed, valuable qualities, both as a non-corrosive insulator and an absolute moisture proof armor and has adhesive qualities of a high order. Containing 33 per cent. pure gum rubber, it is said to exceed rubber itself in insulating qualities and is nearly fireproof. Messrs. Joseph Ketchum & Company have equipped a large plant in Brooklyn, N. Y., for its manufacture in the form of cement, paint, tape and tubing, and report a flourishing trade already. "D D" is the trade mark under which it is sold. Its close adherence to wood or metal, with its plastic quality and freedom from cracks and splits, should recommend it to station managers and purchasers generally.

The Elektron Manufacturing Company, 79 and 81 Washington street, Brooklyn, have recently sold to Messrs. Warfel & Geist, of Lancaster, Pa., 30 horse-power in Perret electric motors. These machines will be supplied with current by the Edison Electric Illuminating Company, of Lancaster, and will furnish power for all the machinery in the large brick building recently completed by Messrs. Warfel & Geist, including large Hoe presses for printing the the daily and weekly *New Era*, as well as all the job presses, which go to make up one of the best and largest printing establishments in the State. Messrs. Warfel & Geist, after a thorough investigation and a visit to Brooklyn and New York, where they witnessed the motors in operation, placed their contract for Perret machines. The following is a sample of the testimonials now being received by the Elektron Manufacturing Company:

MINNEAPOLIS, MINN. Dec. 3d, 1890.
MR. F. J. RENZ, Agent,

Dear Sir:—In reply to yours of the 3d in regard to testimonials, will say that I am so well pleased with the Perret motor in *all respects* that I will permit your people to write anything they see fit over my name, providing it is *all in favor* of the *Perret*, and will do all I can in any way to help you in Minneapolis. Yours respectfully,

F. G. WARD, *Manager*.
The Great Atantic & Pacific Tea Co.

At this gay season of good cheer,
Paiste wishes you a glad New Year.
Cannot you do for Paiste the same,
And buy the goods that bear his name?
He wants your orders, please remember,
From now clear on till next December.

SWITCHES,
CUT-OUTS,
SOCKETS.
H. T. PAISTE,
1201 MARKET STREET, PHILADELPHIA.
PAISTE SPECIALTIES KEPT IN STOCK BY ALL PROMINENT SUPPLY HOUSES.

Washburn & Moen Enlarging.—It is reported that the Washburn & Moen Wire Company, of Worcester, are considering building a branch of their plant at Marlboro, Mass. Recently several of the officials of this company visited Marlboro, and looked over the place with the hope of securing a suitable site for a building. Nothing definite was done, and here the matter has dropped at least for a while. The residents are anxious to secure the industry.

A Syracuse Industry.

The Electric Engineering and Supply Company, of Syracuse, N. Y., are about to remove to a new factory having four times the capacity of the one now occupied. They make a socket called the E. E. & S. key socket which is selling well.

"I advise all parents to have their boys and girls taught shorthand writing and typewriting. A stenographer who can typewrite his notes would be safer from poverty than a great Greek scholar."—CHARLES READE, on "The Coming Man."

REMINGTON STANDARD TYPEWRITER.

For 15 years the Standard, and to-day the most perfect development of the writing machine, embodying the latest and highest achievements of inventive and mechanical skill. We add to the Remington every improvement that study and capital can secure.

Wyckoff, Seamans & Benedict,
327 BROADWAY, NEW YORK.

PATENT PERFORATED
ELECTRIC LEATHER BELTING

MANUFACTURED BY
Charles A. Schieren & Co.,
45, 47, 49, 51 FERRY ST.,
COR. CLIFF ST.

BRANCHES:
BOSTON, 119 HIGH STREET.
PHILADELPHIA, 226 NORTH 3d STREET.
CHICAGO, 46 SOUTH CANAL STREET.

Burnley Dry Battery
PATENTED JAN., 1890.

STRONGER than any Open Circuit Battery on the Market. BETTER than any other Dry Battery yet produced. Most compact in size and cheapest. 90 cents per cell. Discount to the Trade and in quantities.

J. H. BUNNELL & CO.,
Sole Manufacturers and General Agents,
76 CORTLANDT ST., N. Y.

THE LAW
Double Cylinder Battery.

Surface of negative element and quantity of solution double that found in any other open circuit cell.

Weigh carefully these advantages.

Its sale has steadily increased for ten years.

LAW TELEPHONE CO.,
Sole Makers,
87 JOHN STREET, NEW YORK.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON DECEMBER 23, 1890.

443,084 Electric railway; Edward M. Bentley, New York, N. Y.

443,097 Electric street light; Geo. M. Kim, Allegheny, Pa.

443,111 Printing telegraph; Frank B. Rae, Chicago, Ill.

443,134 443,135 443,136 Printing telegraph; Samuel V. B. Essick, Brooklyn, N. Y.

443,145 Telephone circuit and apparatus; James L. McQuanie, Boston, Mass., assignor to the New England Telephone and Telegraph Co., same place.

443,149 Railway switch operating system. 443,167 Electrically operated railway switch; Samuel L. Powell, Lewiston, assignor of one-half to Frederick D. Morrison, Baltimore, Md.

443,157 Electrical signaling apparatus; Ambrose B. Wyckoff, Washington, D. C., assignor of three-fifths to Joseph Warren Coulston, Philadelphia, Pa.

443,154 Insulator; William L. R. Emmet, East Rockaway, N. Y.

443,181 System of electrical distribution; Henry A. Rowland and Louis Duncan, Baltimore, Md.

443,187 Electric insulator; Foree Bain, Chicago, Ill.

443,195 Cut-out; Geo. W. Mingle, Philadelphia, Pa.

443,219 Galvanic battery; Horatio J. Brewer, New York, N. Y.

443,224 Electric welding apparatus; Hermann Lemp, Lynn, Mass., assignor to the Thomson Electric Welding Co., of Maine.

443,226 Electric belt; John L. Pratt, David City, Neb.

443,227 Mounting for electric motors; Andrew L. Riker, New York, N. Y.

443,237 Apparatus for painting electric wires and their coverings; Richard W. Heppell, Dunkirk, N. Y.

443,259 Device for transmitting motion; Johannes T. Pedersen, New York, N. Y.

443,270 Machine for dressing the commutators in dynamo machines; Geo. P. Cummings, New York, N. Y.

443,282 443,283 Electric safety device for elevators; Herbert E. Holmes, West Springfield, and Chas. F. Grosvenor, Ludlow, Mass.

443,291 Electro-mechanical central system for regulating clocks; Carl A. Mayrhofer, Berlin, Germany, assignor, by mesne assignments, to the Electro-Pneumatic Time Co., New York, N. Y.

443,360 Recording pressure gauge; Jarvis B. Edson, New York, N. Y.

443,381 Telegraph transmitter; Samuel W. Smith, New York, N. Y.

443,404 Circuit breaker and closer; John S. Potter, Newton, and David J. Cartwright, Boston, Mass.; said Cartwright assignor to said Potter.

443,407 Dynamo electric machine; Chas. P. Scheuritzel and John L. Hess, Brooklyn, N. Y.

443,435 Watchman's time recorder; Isham D. Fuller, Chicago, Ill., assignor, by mesne assignments, to the Fuller Watchman's Electrical Detector Co., same place.

443,451 443,452 Electric railway; Rudolph M. Hunter, Philadelphia, Pa., assignor to the Electric Car Co. of America, same place.

443,454 443,455 Electrode for secondary batteries. 443,456 443,457 Secondary battery; Isidor Kitsee, Cincinnati, O., assignor to Mayer Sulzberger, trustee, Philadelphia, Pa.

443,475 Electric cash register; Willard L. Bundy, Auburn, N. Y.

443,478 Fire alarm system; Frederick T. Fearey, Newark, and John Speicher, Jersey City, N. J., assignors to the Newark District Telegraph Co., of New Jersey.

443,487 Gas and electric light fixture; Charles Felton, Denver, Colo., assignor of one-half to Thos. P. Hughes, same place.

IF YOU HAVE A BATTERY—Gravity or Leclanche—use the Delany battery strip. It prevents the salt from creeping, keeps batteries and shelves clean, prevents local action, and prolongs life of battery. Warranted. Price per dozen—Gravity, 60 cents; Leclanche, 50 cents.
PATRICK B. DELANY,
SOUTH ORANGE, N. J.

ELECTRIC MANUFACTURING OR CONSTRUCTION COMPANIES.

I WANT a responsible position. Thoroughly understand the business; am a practical man and believe I can satisfactorily fill any position, from Manager or Superintendent down. I have a number of entirely new and valuable electrical devices, which party I would engage with could acquire or would like some backing to push them. Am well-known and a hard worker of over ten years' practical experience. Address
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Care "Electrical Review," 13 Park Row, New York.

ELECTRIX SWITCH.

ELECTRIX SPECIALTIES.
Endorsed the World over by Users.
Simple. Reliable. Indestructible.
DEALERS REPORT QUICK SALES.
CORRESPONDENCE INVITED.
THE STAR ELECTRIX CO.,
1320 Wallace St., Philadelphia, Pa.

THE HIGHEST

ABRASION-RESISTING AND STRONGEST WIRES IN EXISTENCE

— ARE THE —

AMERICAN CIRCULAR LOOM COMPANY'S

"CANVAS JACKET"

INSULATED WIRES AND CABLES,

BOSTON: 620 ATLANTIC AVENUE.

SELLING AGENTS:

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BAKER & CO.,

Importers, Melters and Refiners of

PLATINUM,

408, 410, 412 and 414 N. J. R.R. Ave., NEWARK, N. J.

Platinum in sheet and wire, all sizes, and any degree of hardness. Scrap and native platinum purchased

CARDEW VOLTMETERS.

These are the only standard Voltmeters that can be used on *ALTERNATING* as well as *DIRECT CIRCUITS.*

DIRECT READING. DEAD BEAT.

CAN BE LEFT IN CIRCUIT CONTINUOUSLY.

Send for Catalogue 1-66 of Electrical Test Instruments.

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THE BILLINGS AND SPENCER COMPANY,

HARTFORD, CONN.

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PURE COPPER COMMUTATOR BARS

FOR ELECTRIC MOTORS OR GENERATORS,

STEEL COMMUTATOR RINGS AND NUTS,

STEEL WRENCHES AND EYE BOLTS.

PATENTED NOV. 5TH 1889

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THE HORIZONTAL

Drilling and Boring Machine

IS A SPECIAL TOOL FOR BORING THE

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Its Product Exceeds that of Three Boring Lathes.

Send for particulars to the Newark Machine Tool Works, NEWARK, N. J.

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MANUFACTURERS OF A FULL LINE OF

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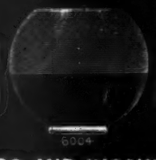
GLOBES  SHADES

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RICH CUT, OPAL, CLEAR, ETCHED, ROUGHED, ETC.

ADAPTED TO ALL SYSTEMS.

729 BROADWAY, NEW YORK.
(COR. WAVERLY PLACE), AND
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ELECTRIC BELL

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THE STANDARD OPEN CIRCUIT BATTERIES OF THE WORLD!

For 20 years these Batteries have maintained their superiority over all others and stand to-day unequalled and unapproachable. Refuse to take any cell unless it bears the Trade Mark, "Gonda."

THE LECLANCHÉ BATTERY CO.,

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FOR ELECTRICAL WORK, IN ALL KINDS OF WOOD.

Office and Storehouse: 150 and 552 West 38th Street NEW YORK.

Independent Bung Co.

Large Stock Always on Hand.

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The Only PERFECT INSULATING SYSTEM FOR UNDERGROUND ELECTRIC WIRES is the

INDURATED FIBRE PIPE,

STRONG, Durable, Absolutely Proof against Moisture, ✳ ✳

✳ ✳ The Action of Acids and Cases of the Earth.

SUBJECTED TO EVERY PRACTICAL TEST.

UNDERGROUND FOUR YEARS WITHOUT DETERIORATION.

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Underwriters' Copper Electric Light Line Wire, handsomely finished, highest conductivity. Copper Magnet Wire, Flexible Silk, Cotton and Worsted Cords for Incandescent Lighting. Round and Flat Copper Bars for Station Work. Insulated Iron Pressure Wire.

TRADE MARK "K.K."

PATENT "K. K." LINE WIRE

TRADE MARK "K.K."

For Electric Light, Electric Railways, Motors, Telegraph and Telephone Use.

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Do You Want { The Best Goods / Good Prices / PROMPT SHIPMENTS } ?

IF YOU DO, WRITE US FOR QUOTATIONS.

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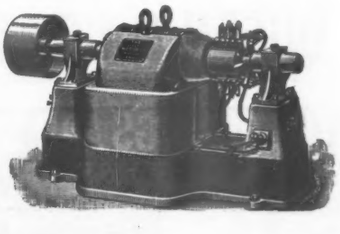

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THE PERKINS ELECTRIC SWITCH MFG. CO.

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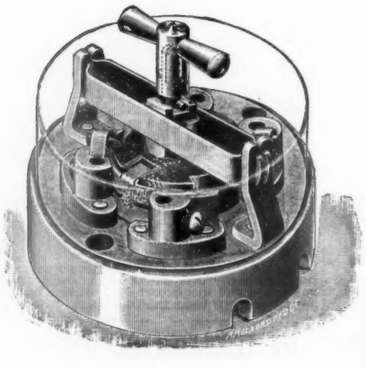
✳ THE PERKINS INCANDESCENT SWITCHES. ✳



Made with Porcelain Bases only.

No. 1.	**Capacity up to**	**10**	**Amperes,**	**Single Pole.**			
No. 2.	"	"	"	**15**	"	**Double Pole.**	
No. 3.	"	"	"	**30**	"	"	"
No. 4.	"	"	"	**40**	"	"	"
No. 5.	"	"	"	**75**	"	"	" } **In**
No. 6.	"	"	"	**100**	"	"	" } **preparation.**

Rated with continuous current; with alternating current their capacity is increased 50 per cent.

All parts made to gauge and interchangeable. Every Switch Guaranteed. Correspondence Solicited.

IMPORTANT INFORMATION TO THE TRADE.

We carry a large stock of House Supplies, including Annunciators, Speaking Tubes, Bells, Batteries, Push Buttons, etc.
We are the Eastern Agents for J. H. Bunnell & Co., of New York, and Sole Agents for the Carr Metal Co.'s Improved Zincs. Also sole New England Agents for

BUNNELL'S NO. 4 HOME MEDICAL BATTERY AND BURNLEY DRY BATTERY.

Send for Price List of our Novelties and Specialties. We are Manufacturers and Dealers in

Telegraph, Telephone, Electric Light and Gas Lighting Supplies.

OUR PRICES ARE ALWAYS THE LOWEST.

THE EASTERN ELECTRICAL SUPPLY AND CONSTRUCTION COMPANY,

No. 65 OLIVER STREET, - - - - - - - - - BOSTON.

LIST OF DYNAMOS IN STOCK.

Designation of Machine.	No. Lights 2,000 c. p. 10 amp. X	No. Lights 1,600 c. p. 8 amp. Y	No. Lights 1,200 c. p. 6 amp. Z	No. Lights 800 c. p. 4 amp.	Horse-Power at Pulley of Dynamo.	Width of Single Belt in Inches.	Belt Speed Required. 5,000 FEET PER MINUTE.	Weight of Dynamo.
C	8	.....	.....	.....	6.5	1¼		530
C	.....	10	.....	.....	6.3	1¼		530
C	.....	.....	.....	25	8.0	2		530
E	16	.....	.....	.....	12.0	2½		780
E	.....	20	.....	.....	12.5	2½		780
E	.....	.....	26	.....	13.0	2½		780
F	20	.....	.....	.....	15.0	3		990
F	.....	25	.....	.....	15.6	3		990
F	.....	.....	33	.....	15.0	3		990
F	.....	.....	.....	50	16.0	3		990
G	28	.....	.....	.....	21.0	4½		1,360

Ball Electric Light Co.
404
WEST 27th STREET.
NEW YORK

LIST OF DYNAMOS IN STOCK.

Designation of Machine.	No. Lights 2,000 c. p. 10 amp. X	No. Lights 1,600 c. p. 8 amp. Y	No. Lights 1,200 c. p. 6 amp. Z	No. Lights 800 c. p. 4 amp.	Horse-Power at Pulley of Dynamo.	Width of Single Belt in Inches.	Belt Speed Required. 5,000 FEET PER MINUTE.	Weight of Dynamo.
G	.....	35	.....	.....	21.0	4		1,360
G	.....	.....	45	.....	21.0	4		1,360
G	.....	.....	.....	70	21.0	4½		1,360
H	40	.....	.....	.....	29.7	6		1,750
H	.....	50	.....	.....	30.0	6		1,750
H	.....	.....	64	.....	29.5	6		1,750
I	52	.....	.....	.....	38.0	8		2,290
I	.....	65	.....	.....	38.6	8		2,290
I	.....	.....	83	.....	38.0	8		2,290
J	64	.....	.....	.....	46.5	10		2,770
J	.....	80	.....	.....	47.1	10		2,770
K	75	.....	.....	.....	52.5	12		3,200

Dr. Gassner's Dry Battery

— FOR —

OPEN CIRCUIT WORK.

THE BATTERIES ARE NOW MADE IN THE FOLLOWING SIZES:

No.		Height.	Width.
18.	Rectangular (Double Cell),	7½ in.	3⅛ in. x 3½ in.
17.	"	7½ "	3⅛ " 1⅝ "
16.	Cylindrical (Enameled)	7 "	3 in. diam.
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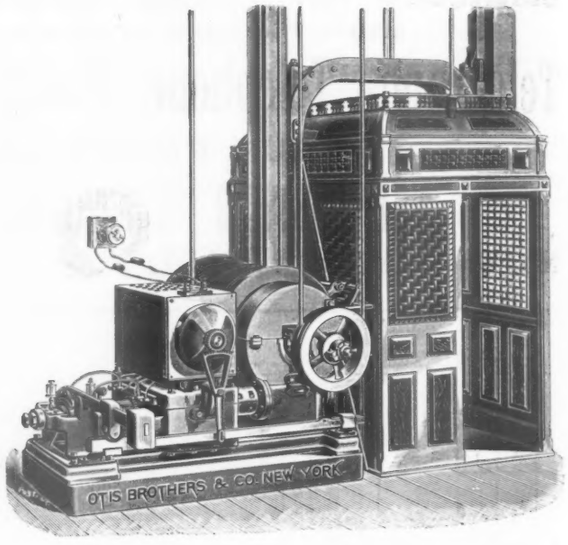

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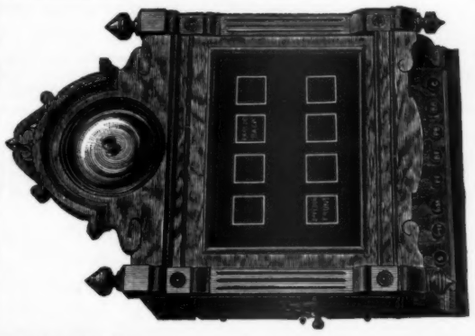

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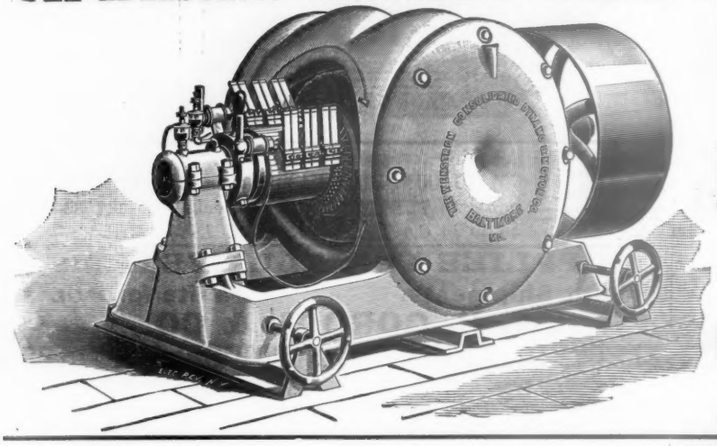

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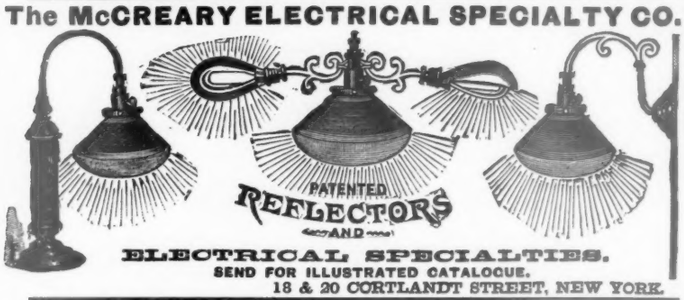

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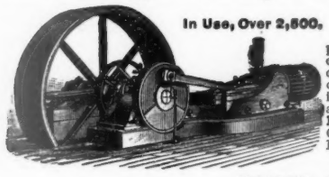

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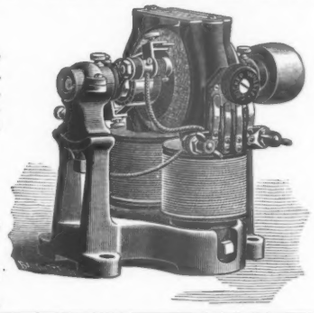

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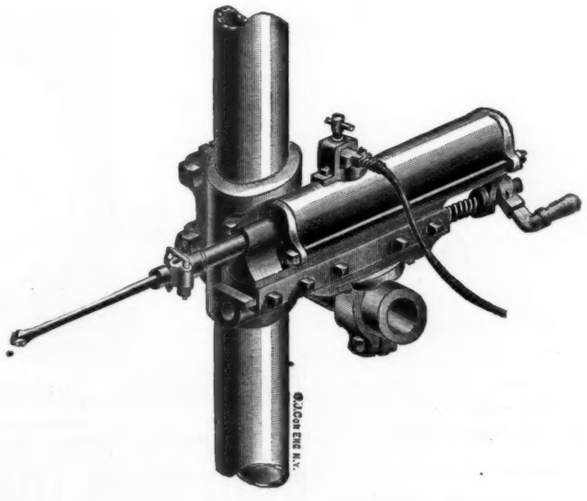

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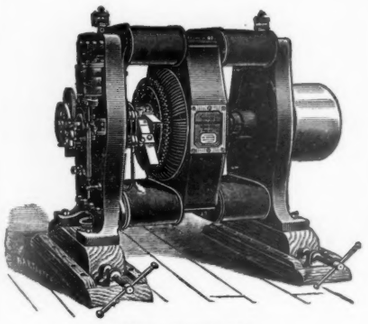

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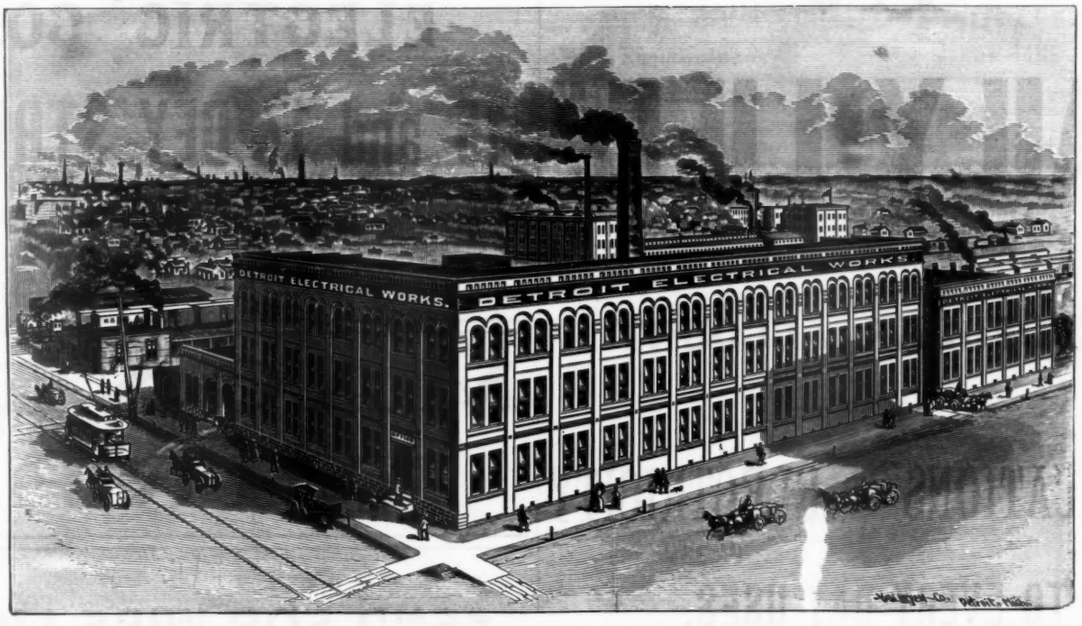

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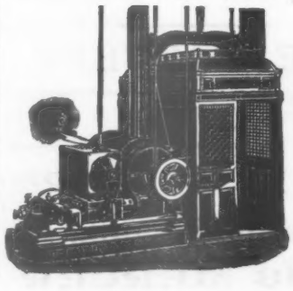

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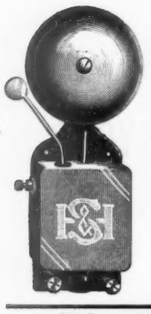

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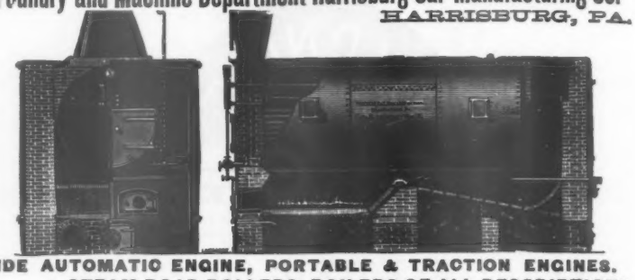

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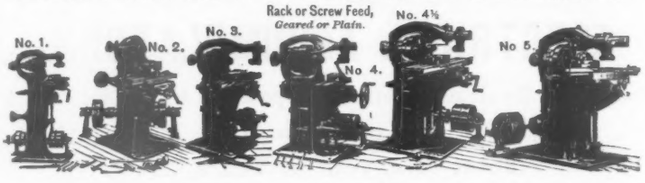

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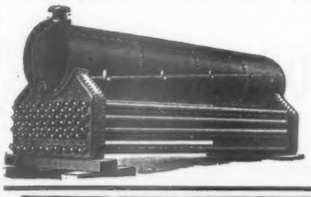

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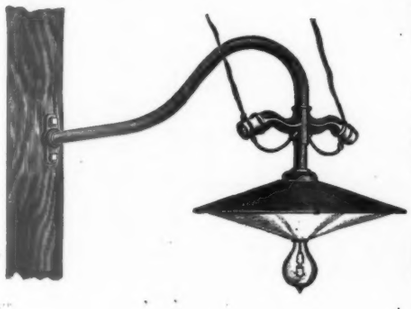
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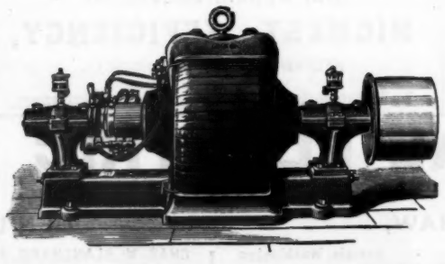
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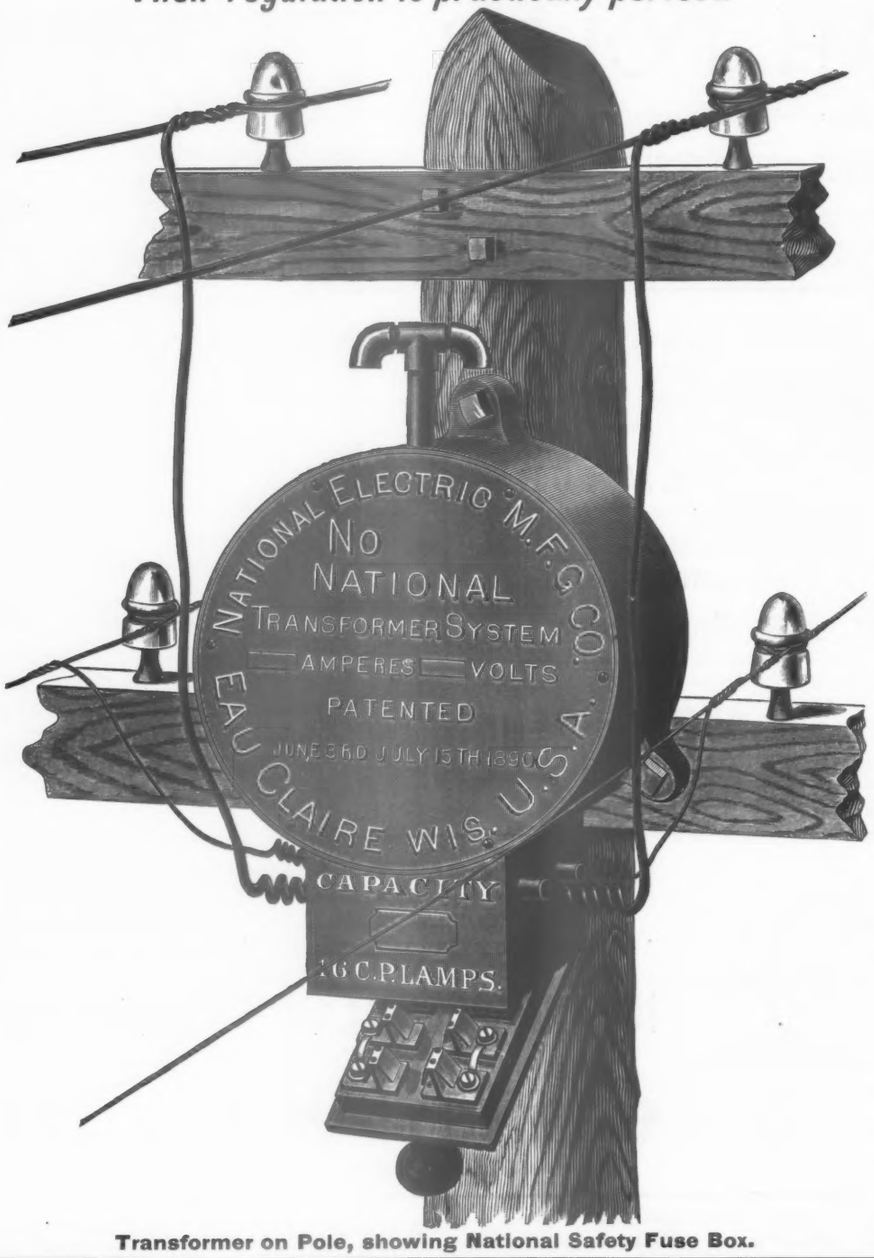

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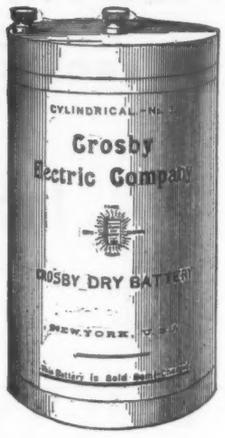

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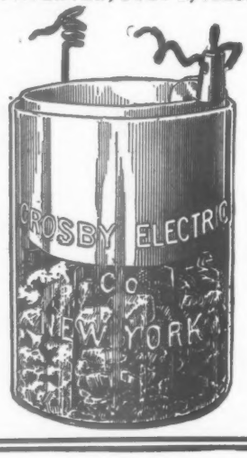

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